Heterogeneity in Firm Environmental Management Activity: Antecedents and Operational Impacts

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Dedication

I dedicate this work to my loving wife, Yelena, who has limitless patience and love, and to our wonderful children: Nicholas, Alexander, and Natalia. Without their collective support, this journey could not have been possible.

Abstract

In response to ever-increasing societal concern, firms adopt environmental management practices (EMPs) to mitigate the impact of their operations on the natural environment. However, they vary significantly in the number and types of practices they adopt, and in the environmental performance derived from that adoption. While prior research has explored various drivers of firm environmental activity and the impact of that activity on firm performance, there is limited understanding of what drives *variation* in adoption between firms and how that variation impacts *operational decisions*. I focus my dissertation on these two questions and execute my investigation through three essays.

In the first essay, I evaluate which stakeholders exert more/less influence on EMP adoption decisions. Using panel data from 2002 to 2013, which includes 880 firms, 258 industries, and 8 sectors, and Hierarchical Linear Modeling, I find that the passage of time, firm-unique choices, and industry membership explain 40%, 26%, and 34% of the observed variation between firms respectively. The results suggest that stakeholders which influence firms directly (firm - 26%), such as customers and investors, are almost as influential to EMP adoption choices as regulators, who influence firms through industry regulation (industry - 34%). The results highlight the important role non-regulatory forces play in motivating firms to increase environmental activity and their potential role in future efforts to motivate improved environmental performance.

I next examine a new source of variation in EMP adoption, a spill or pollution (SP) controversy. Such controversies are increasingly common. Because EMP adoption directly drives environmental performance, understanding how firms respond to SP controversies (escalate or de-escalate adoption) is of importance to both society and regulators. Using a unique panel data from 2002 to 2013, I show that in the absence of a SP controversy, firms steadily adopt more EMPs each year. However, in the year following a SP controversy, they de-escalate adoption and this effect seems to persist for up to 3 years. I also observe that high sustainability firms do not de-escalate adoption following a SP controversy, highlighting the critical role of sustainability leadership to driving environmental performance.

In the final essay, I investigate how poor environmental performance can impact firms in surprising, yet important ways. I specifically investigate whether experiencing an environmental controversy impacts a subsequent, seemingly-unrelated operational decision, the timing of a product recall. Using a panel dataset covering 2002 to 2013, which includes recalls from the five

primary recalling industries (auto, pharma, medical device, food, and consumer products), and survival modeling, I find that experiencing environmental controversy, or more controversies, causes firms to postpone the product recall decision. This impact is consistent across each recalling industry. I also find that as the controversy ages, its impact on the recall decision diminishes, suggesting the recent controversies will have a greater impact on operational decisions than older controversies.

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Chapter 1 - Dissertation Overview

As a function of their operations, firms of all types negatively impact the natural environment. They do this through some combination of energy and natural resource *consumption* and operational waste *emission* into the air, soil, and water. For instance, all firms consume energy, which is often produced at fossil fuel burning power plants. The burning of fossil fuels emits greenhouse gases (such as carbon dioxide, methane, nitrous oxide, ozone, and water vapor) into the atmosphere, which in turn is believed to contribute to global warming and climate change.[1] Experts estimate that by 2030, global warming will cause an additional 250,000 deaths annually around the globe, as well as increase annual healthcare spending in the U.S. by $2 billion - $4 billion.[2] The burning of fossil fuels also generates other harmful emissions, including sulfur and nitrogen oxides which contribute to smog and acid rain, microscopic particulate matter, radioactive material, and heavy elements such as mercury, arsenic, and others. These power plants also consume large quantities of water. In the U.S., fossil-fuel powered plants produce approximately 65% of all electrical power[3] and annually emit 2.8 billion tons of carbon dioxide.[4]

Manufacturing firms generate additional environmental impacts through production resource consumption and waste generation. Production *resources* are obtained from the natural environment and may be non-renewable, such as fossil fuels, minerals, and water. Production *wastes*, which may be hazardous or non-hazardous, are often emitted directly into the air, land-filled, released into local waterways as waste water, poorly contained and leak into the soil (and possibly the watershed), or released into the environment through a myriad of other paths. The impact of pollution on the planet and population is significant. Experts estimate that pollution causes 100 million deaths annually around the globe[5], 3 million of which are children under the age of five.[6] In the United States alone, environmental spill and pollution events such as Love canal, Three-mile island, the Exxon-Valdez oil spill in Alaska, and the BP oil spill in the Gulf of Mexico, require significant financial resources for clean-up, while leaving the environment permanently scarred. For example, the BP Oil Spill discharged more than 4.5 million barrels of

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[1] Intergovernmental Panel on Climate Change (IPCC) report *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability*
[2] World Health Organization (WHO) 2017 Fact Sheet
[3] https://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states
[4] http://www.sciencedaily.com/releases/2007/11/071114163448.htm
[5] World Health Organization. "Climate change and health." 2014. Web Accessed April 25, 2015
[6] Blacksmith Institute, Green Cross. "The World's Worst Pollution Problems: The Top Ten of the Toxic Twenty." Web Accessed April 25, 2015

toxic oil in the Gulf of Mexico and affected over 8000 species of flora and fauna. It was also responsible for eleven deaths and cost BP $18.7 billion, the largest corporate settlement in U.S. history. Even non-manufacturing firms consume natural resources and generate harmful emissions. For example, transportation firms generate hazardous air emissions, mining firms consume water and generate hazardous wastes which often pollute the soil, groundwater, and local waterways, and construction firms consume natural resources while generating production wastes, which are often landfilled.

To reduce the impact of their operations, or supply chain, on the natural environment, firms adopt operational changes called natural environmental management items (Aragon-Correa 1998), environmental technologies (Klassen & Whybark 1999), environmental actions (Banerjee 2001), and environmental management practices (Yang et al. 2011, Delmas & Toffel 2008, Montabon et al. 2007, Delmas & Toffel 2004, Anton et al. 2004, Sroufe et al. 2003, Khanna & Anton 2002). Consistent with recent literature, I refer to these operational changes as "environmental management practices" (EMPs) and their usage by a firm as "EMP adoption". Examples of EMPs firms adopt include process and technology changes, revised management systems and policies (such as implementing KPIs), revised governance structures (such as placing environmental leaders in senior roles), participation in external partnerships designed to address environmental issues, commitment to environmental protocols (such as the Ceres Valdez principles), and managing supplier emissions (such as through scorecards).

My data shows that U.S. firms, on average, steadily adopt more EMPs each year (Figure 1.1), with consistent increases occurring across a variety of sectors representing the broad spectrum of U.S. economic activity (Figure 1.2). However, despite such encouraging increases in "average" adoption, a deeper investigation reveals significant variation in the number of EMPs individual firms adopt, even firms within a common industry. While some firms adopt many EMPs, others adopt few, if any. This pattern of variation exists across all years in the panel and the magnitude of the variation increases over time (Figure 1.3 – the boxes represent min and max levels of adoption for each year).

Figure 1.1 – Average firm-level adoption of EMPs (2002 – 2013)

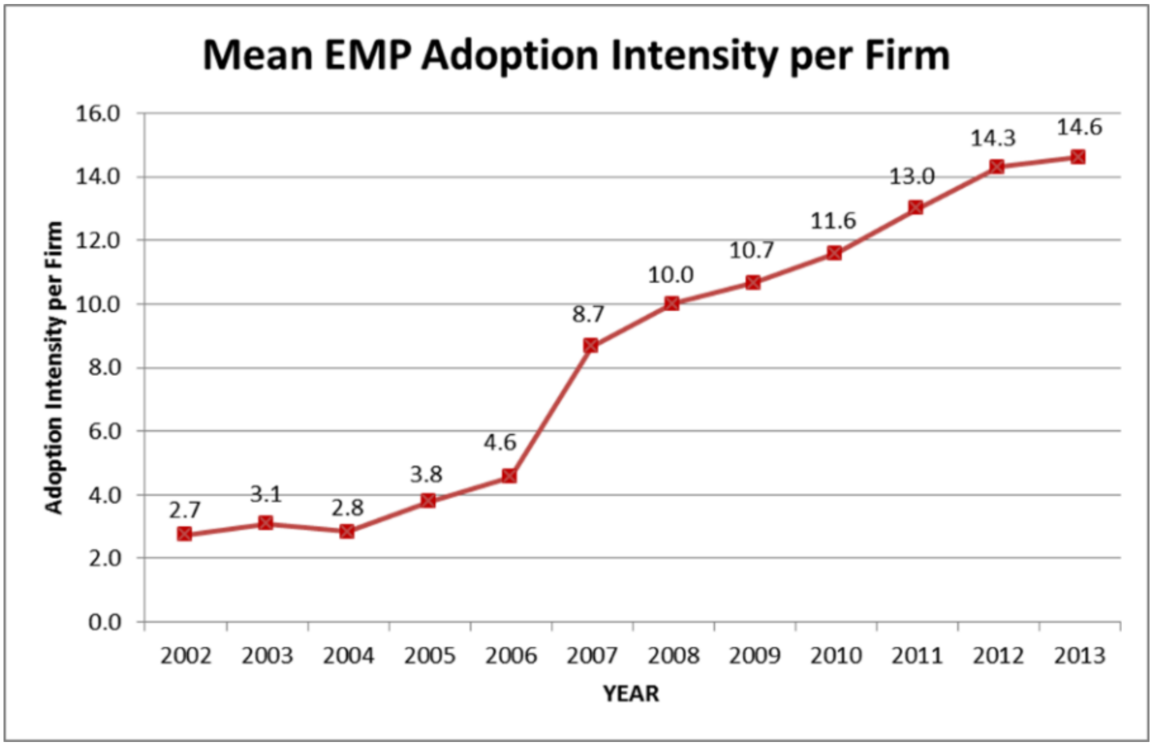


Figure 1.2 – Average firm-level adoption of EMPs (by Sector)

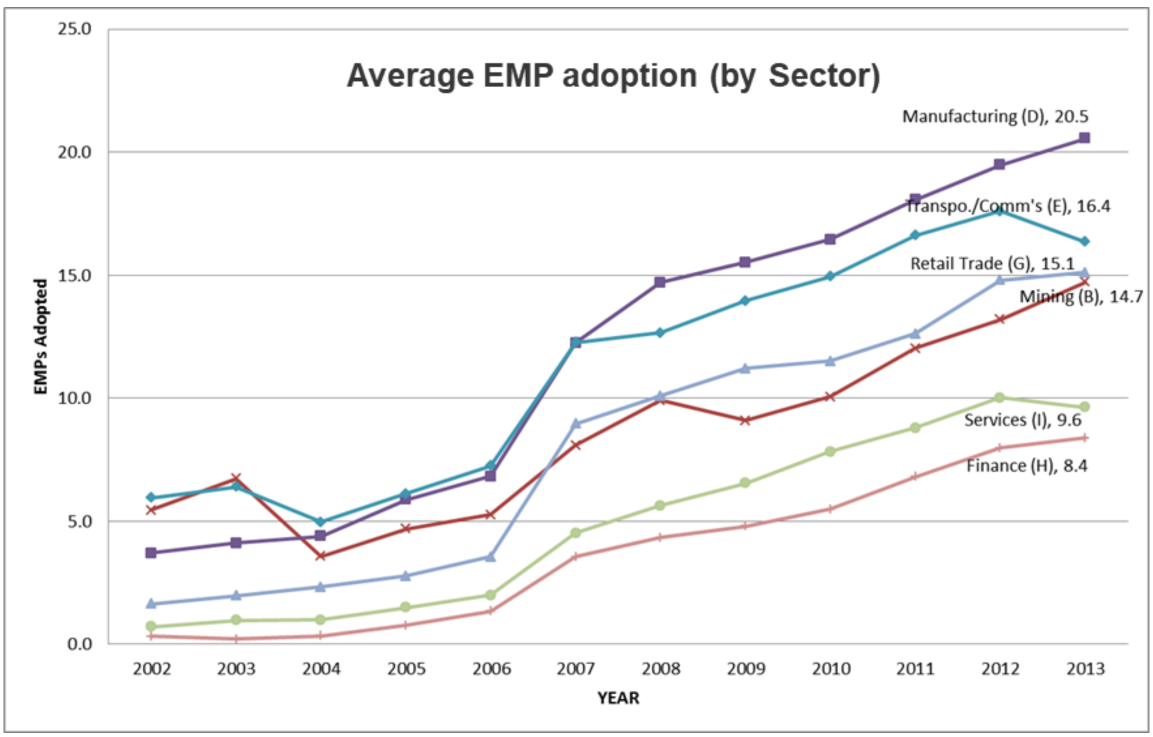
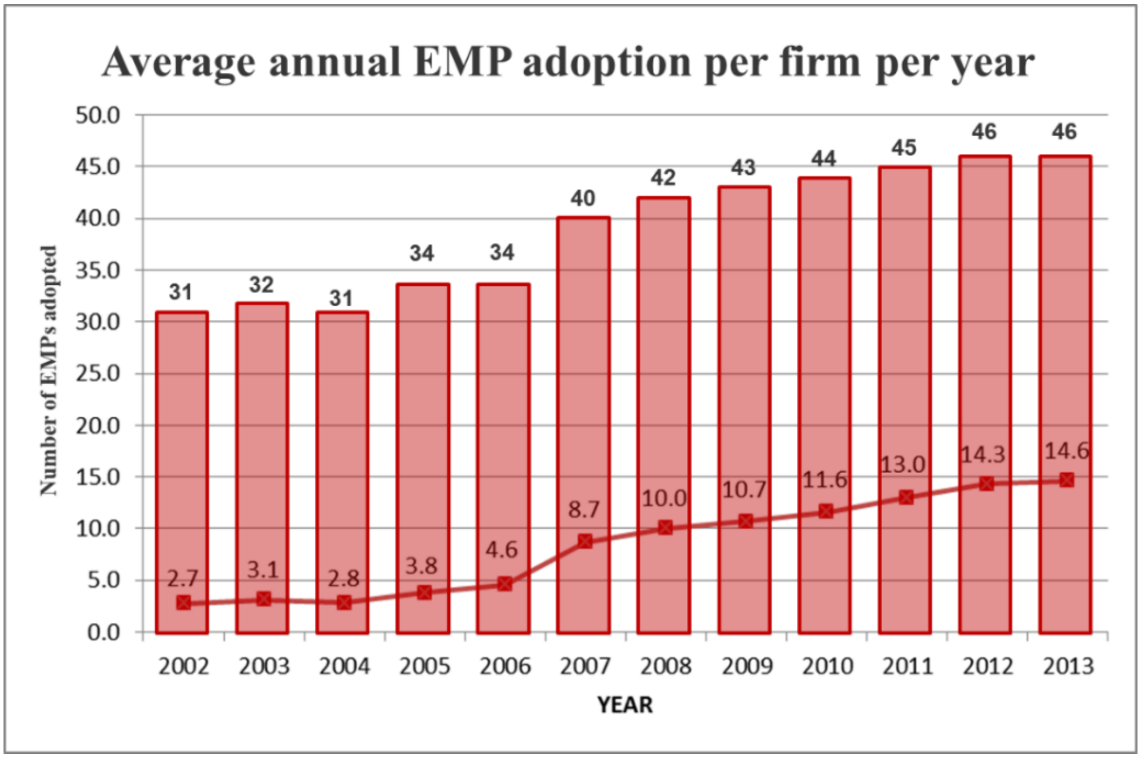


Figure 1.3 – Variation in firm-level adoption of EMPs



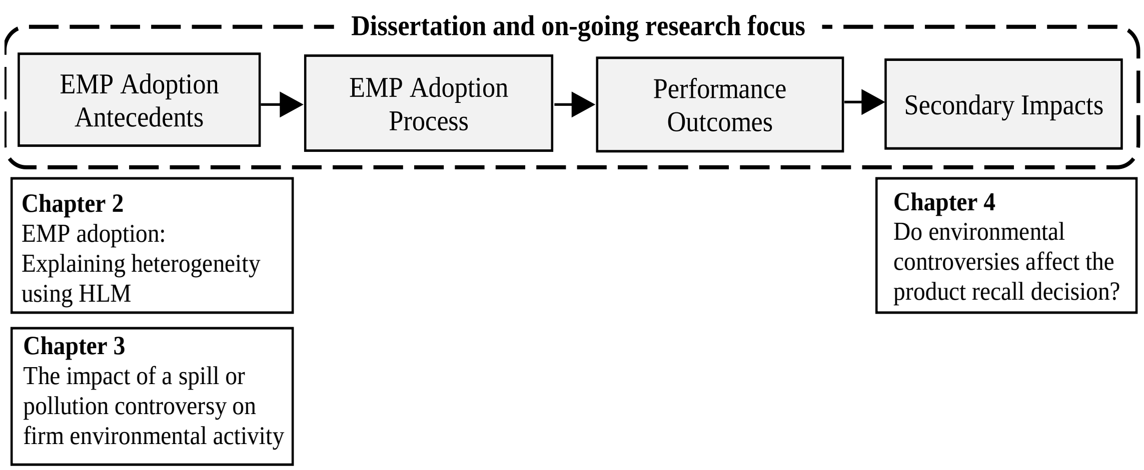
Two broad streams of research investigate EMP adoption. The first examines *why* firms adopt EMPs and the second investigates *causes and consequences* of EMP adoption. As to the first stream, environment management researchers have attempted to address why firms adopt EMPs by focusing on the drivers of EMP adoption. The central premise in these studies is that various external and internal stakeholders (e.g., regulatory agencies, customers, competitors, employees etc…) exert significant pressure on firms to adopt EMPs (Sarkis et al. 2010, Ruenda-Manzanares et al. 2008, Buysse & Verbeke 2003, Banerjee et al. 2003, Madsen & Ulhoi 2001, Henriques & Sadorsky 1996). According to these researchers, firms adopt EMPs to comply with existing regulations, avoid penalties, and as a signal to pacify relevant stakeholder groups. An important outcome from the second stream of research is that EMP adoption is positively associated with superior environmental (Anton et al. 2004, Klassen & Whybark 1999, Potoski & Prakash 2005, Toffel 2005, King & Lenox 2002), operational (Sroufe 2003) and financial performance (King & Lenox 2002). Table 1.1 provides an overview of pertinent literature in this area.

Table 1.1 – Representative literature

Article	Country/ Industry	Research Focus	Independent Variable	Dependent Variable	Results
Hofer, Cantor & Dai (2012)	North America (Manufacturing)	Competitive determinants of EMP adoption	Rival firms past EM activity	Focal firm EMP adoption	A firm's EMP activities are driven in part by the actions of competitors.
Sarkis, Gonzalez-Torre & Adenso-Diaz (2010)	Spain (Auto industry)	Impact of environmental training on EMP adoption	Stakeholder Pressure	EMP adoption	Environmental training mediates the relationship between stakeholder pressures and EMP adoption.
Delmas & Toffel (2008)	United States (Heavy polluting industrial sectors)	Influence of influential corporate departments on EMP adoption	Stakeholder pressure	EMP adoption	Differences in the influence of corporate departments lead facilities to prioritize different external pressures and thus adopt different EMPs.
Zhang, Bi, Yuan, Ge, Liu & Bu (2008)	China (Chemical manufacturers)	Influence of various external stakeholder on EMP adoption	Stakeholder pressure	EMP adoption	Pressures from supply chain partners, customers, and communities influence firms to increase EMP adoption. Regulatory influence reduces with increased compliance.
Potoski & Prakash (2005)	United States (Manufacturing)	Relationship between ISO 14001 and environmental performance	ISO 14001 certification	TRI emissions	Certified ISO 14001 facilities reduce their emissions greater than non-certified facilities.
Anton, Deltas & Khanna (2004)	United States (S&P 500 firms)	Motivation to adopt EMPs and the impact of EMPs on environmental performance.	Stakeholder pressure EMP adoption	EMP adoption & TRI emissions	Liability threats and pressures from consumers, investors and the public motivate EMS adoption. A more comprehensive EMS leads to lower toxic emissions per unit output.
Sroufe (2003)	United States (Manufacturing)	Relationship between environmental activity and operational performance	EMP adoption	Operational performance	Increased EMP adoption leads to improved operational performance.
Khanna & Anton (2002)	United States (S&P 500 firms)	Factors that explain the diversity in the EMSs adopted by firms	Stakeholder pressure	EMP adoption	The threat of environmental liabilities, high costs of compliance, market pressures, and public pressures on firms create incentives for adopting a more comprehensive EMS.
King & Lenox (2002)	United States (Manufacturing)	Identify locus of profitable pollution reduction	On-site vs. off-site treatment of toxic emissions	ROA, Tobin's q	Waste prevention leads to financial gain, but reactive approaches to reducing pollution do not.
King & Lenox (2001)	United States (Manufacturers)	Impact of Lean production on environmental performance	ISO 9001 Max. invention levels	EMP adoption TRI emissions Waste treatment	Firms that deploy lean are more likely to adopt ISO 14001, reduce waste generation, and reduce hazardous emissions.
Klassen (2001)	United States (Furniture manufacturing)	Impact of leadership environmental orientation on EMP adoption	Leaderships views on environmental responsibility	EMP adoption (proactive vs. reactive)	More optimistic leadership orientation leads to proactive adoption of EMPs and vice versa.
Klassen & Whybark (1999)	United States (Furniture manufacturing)	Relationship between pollution prevention and firm performance	EMPs adopted (prevention vs. control)	Operations performance TRI emissions	The adoption of pollution prevention techniques improves both operational and environmental performance.

Regardless of the intense pressure firms feel to adopt EMPs from society and other environmental stakeholders, and the tremendous value they derive from adoption, the data shows that firms vary significantly in the number of EMPs they adopt. Further, while existing research has spent considerable effort investigating the causes and consequences of adoption, very little effort has been expended on understanding *variation* in adoption across firms. Investigating the magnitude and causes of variation can provide important insights into firm choices regarding EMP adoption, as well as how those choices impact firm performance and operational decision making. Such insights could be useful in the development of new or revised approaches to increase adoption and improve firm environmental performance. In this dissertation, I investigate variation in firm environmental activity (as proxied by EMP adoption) from two perspectives, i.e. what contributes to variation and how poor environmental performance, shown by prior researchers to be a consequence of variation in adoption, impacts operational decision-making. I conduct the investigation through three (3) essays, each of which individually contributes to the broader issue of variation in EMP adoption (Figure 1.4).

Figure 1.4 – Dissertation structure



I begin by examining antecedents to the adoption of EMPs and the associated variation in adoption across firms. In Chapter 2, "*Environmental Management Practice Adoption: Explaining heterogeneity among firms using Hierarchical Linear Modeling*," I investigate how stakeholders, firm characteristics, and industry attributes contribute to variation in EMP adoption. More specifically, I address two questions: (1) which stakeholders seem to have greater (or lesser) influence on firm-level decisions regarding the adoption of EMPs and (2) which specific firm characteristics and industry attributes support or hinder EMP adoption. As to the first question, it is clear that a wide variety of stakeholders influence firm choices regarding the adoption of EMPs, including regulators, NGOs, customers, supply chain partners, investors, local communities, and firm employees, among others. However, while each of these stakeholders exert influence, it is unknown which stakeholder(s) provide greater (or lesser) influence. Such knowledge would be useful for developing new or revised approaches to increase firm-level adoption of EMPs. As to the impact of firm characteristics and industry attributes on variation in EMP adoption, researchers have shown that, (1) firms adopt in response to regulation (Sarkis et al. 2010, Delmas & Toffel 2004), competition (Henriques & Sadorsky 1996), and pressure from other stakeholders, including non-governmental agencies (Lawrence and Morell 1995), and (2) firms differ in organizational characteristics (e.g., resource availability) and needs directly related to adoption (Sharma et al. 1999). However, it is unclear which specific firm characteristics help or hinder adoption or whether other industry attributes contribute to variation in adoption. Understanding which firm characteristics matter is of importance to firm leaders who are beginning the journey toward environmental excellence. Understanding which industry attributes matter helps quantify the importance of regulation to variation in EMP adoption, as compared to other options for increasing adoption, such as direct pressure on firms or self-regulation approaches, such as ISO 14000 or the Carbon Disclosure Project.

To examine these questions, I use panel data that spans a 12-year period from 2002 to 2013, and includes 880 firms from 258 industries and 8 sectors which represent the broad spectrum of U.S. economic activity. To accommodate the multi-level nested data structure, I use Hierarchical Linear Modeling (HLM; Bryk & Raudenbush 1992). Results from rigorous empirical analysis show that the passage of time, firm-unique choices and characteristics, and industry membership account for 40.0%, 25.7%, and 34.3% respectively of the aggregate variance in EMP adoption. The results suggest that stakeholders that influence firms directly (25.7% of total variance explanation) are almost as important to firm adoption decisions as regulators, who influence firms through the industry in which the firm competes (34.3%). Results from examining industry attributes show that regulation and competition positively impact adoption, while industry munificence, dynamism, and complexity negatively impact adoption. This suggests that as environmental uncertainty increases, firms adopt fewer EMPs, i.e. firms do not see the adoption of EMPs as necessary to grow the firm, address industry instability or handle industry complexity. Results from examining firm characteristics show that firm size, profitability, available labor, and prior experience adopting a quality management system (such as lean, TQM or Six Sigma) or ISO9000 are positively related to adoption, while available capital is unrelated to adoption. Beyond identifying important antecedents to adoption, the results show that firms can be environmentally proactive without excess capital, an encouraging finding for firm leaders who inaccurately assume that it is expensive to pursue a proactive environmental strategy.

While it is clear that environmental stakeholders, firm characteristics and industry attributes play important roles in explaining variation in firm environmental activity, in Chapter 3, "*The impact of a spill or pollution controversy on firm environmental activity*," I investigate another source of variation, a spill or pollution controversy. Such controversies are increasingly common and given the direct connection between EMP adoption and improved firm environmental performance, understanding how firms respond to such controversies (escalate or de-escalate adoption) is of importance to both society and regulators. A spill or pollution event, and the subsequent media controversy, reflects a failure of a firm's environmental management system (EMS), much as a product quality failure reflects a failure of a firm's quality management system. Given that an EMS is comprised of the EMPs a firm has adopted prior to the spill or pollution event, the spill or pollution controversy is an indictment of that embedded base of EMPs. My first objective in the study is to understand how firms respond to such controversies, i.e. do they escalate adoption to make the EMS more robust or do they de-escalate (or pause) the annual increases they pursue in the absence of a controversy as a way to secure time to analyze root cause and identify weaknesses with the current environmental strategy before adopting more EMPs. In addition to examining the direct relationship between a spill or pollution controversy and EMP adoption, I also examine whether the controversy severity, firm size, firm sustainability performance or an industry's environmental risk profile moderate the direct relationship.

Using a unique panel data from 2002 to 2013 representing over 400 publicly-traded US manufacturing firms, and rigorous econometric methods, I show that in the absence of a spill or pollution controversy firms in all sectors steadily adopt more EMPs each year. However, following a spill or pollution controversy firms de-escalate adoption and this effect seems to persist for up to 3 years. It is important to note that de-escalation does not equate to a reduction in the number of EMPs the firm adopted in the prior year. Rather, it is a slowdown in annual increases in adoption and a reduction in the number of EMPs the firm *would have* adopted in the absence of a controversy. I also find that while experiencing more severe controversies or more controversies individually leads to a greater slowdown, they do not jointly affect the number of EMPs a firm adopts. Finally, I observe that high sustainability firms do not de-escalate adoption following a spill or pollution controversy, suggesting that such firms respond differently to spill and pollution controversies than other firms. The results have negative implications for short- and long-term environmental performance, especially because firms do not seem to recover from the slowdown in future years. They also shed light on a commonly held belief that firms escalate adoption in response to an environmental controversy, perhaps to strengthen their environmental management system or achieve legitimacy in their stakeholders' eyes. Instead, firms (in aggregate) de-escalate adoption following a controversy and this behavior persists over time, potentially resulting in a complete pause in adoption. The results also indicate that factors other than stakeholder or institutional pressure, the primary theoretical lenses from which EMP adoption has been studied previously, influence firm decisions regarding adoption (Delmas 2001, Delmas & Toffel 2008, Reuter et al. 2010, Sarkis et al. 2010, Foster et al. 2000, Hofer et al. 2012). Finally, the results demonstrate that sustainability performance plays a critical role in how firms respond to spill and pollution controversies, with potential important implications for firm environmental performance.

Beyond understanding what drives variation in firm environmental activity, I am also interested in understanding how firm EMP adoption choices, and associated environmental performance, impact operational decision making. In the final essay, "*Do environmental controversies affect the product recall decision?*", I investigate how an environmental controversy impacts a seemingly-unrelated operational decision, the timing of a product recall. I specifically investigate whether firms who have experienced prior spill and pollution controversies, and the associated fallout from such socially toxic events, choose to accelerate or decelerate a subsequent voluntary product recall, another socially toxic event. Firm leaders may decelerate a recall out of belief that delaying the recall presents the least risk to their careers or they may accelerate the recall decision to couple the controversy and recall bad news, thereby reducing the informativeness of the recall bad news and its negative impact on the firm. Finally, I investigate whether the impact of environmental controversy on operational decision making dissipates as the time since the most recent controversy increases.

To test the research hypotheses, I compiled a unique dataset by combining environmental controversies from Thomson Reuter's ASSET4 database with an expansive voluntary recall dataset gathered through numerous Freedom of Information Act (FOIA) requests and web-scraping of U.S. regulatory websites. The final sample includes 120 publicly traded firms from 59 4-digit SIC code industries. It also includes 154 environmental controversies and 4355 product recalls representing all major recall industries, including automotive, medical device, pharmaceutical, food, and consumer products. Using survival modeling, I find that experiencing prior environmental controversy, or more controversies, causes firms to delay the product recall decision by almost 50%. I also find that the impact of the controversy on the recall decision diminishes as the controversy ages, suggesting the recent controversies will have a bigger impact on operational decisions than older controversies. However, the rate of decay is extremely slow. Finally, I find that the recall postponement effect is consistent across all recalling industries, but most pronounced in the consumer products and auto industries. The research offers several important contributions. We contribute to the environmental management literature by showing that environmental performance affects a firm's managerial decision making related to product quality. We contribute to the product recall literature by identifying a common leading indicator of recall timing across all U.S. recalling industries (auto, pharma, medical device, food, and consumer products). In fact, this study is perhaps the broadest recall study to-date. Finally, we contribute to information disclosure literature by showing that firms prefer to decouple bad news announcements.

Chapter 2 - Environmental Management Practice Adoption: Explaining heterogeneity among firms using Hierarchical Linear Modeling

2.1 Introduction

Highly visible environmental events in the U.S. and around the world over the past years highlight the significant risks business operations can pose to the natural environment. Examples include the Union Carbide gas leak in Bhopal, India, the Exxon-Valdez oil spill in Alaska, and the Deepwater Horizon oil spill in the Gulf of Mexico. These events have brought increased attention and accountability to firms for the impact their operations have on the natural environment. Evidence suggests that adopting environment management practices (EMPs), which broadly include practices, policies, and procedures designed to reduce the impact of a firm's operations on the natural environment, has increased steadily over the past decade, potentially in response to increased attention. By adopting EMPs, firms not only signal that they are environmentally responsible, but they also reap ancillary benefits associated with adoption such as superior environmental (Anton et al. 2004, Klassen & Whybark 1999, Potoski & Prakash 2005, Toffel 2005, King & Lenox 2002), operational (Sroufe 2003) and financial performance (King & Lenox 2002).

Despite such proven benefits, researchers have found that firms vary significantly in the number of EMPs they adopt (Sarkis et al. 2010, Delmas & Toffel 2004, Henriques & Sadorsky 1996, Sharma et al. 1999). While they concur that one source of variation is time (King et al. 2005, Delmas 2003), possibly due to increased public pressure over time,[7] there is a lack of consensus on other sources and the relative importance of each source to the adoption decision. To address this question, existing studies have used institutional, organizational, and stakeholder theories to identify and analyze how factors external and internal to the firm impact EMP adoption. They conclude that adoption varies because; (1) firms adopt in response to regulation (Sarkis et al. 2010, Delmas & Toffel 2004), competition (Henriques & Sadorsky 1996), and pressure from other stakeholders, including non-governmental agencies (Lawrence & Morell 1995) and (2) firms differ in organizational characteristics (e.g., resource availability) and needs directly related to adoption (Sharma et al. 1999). In fact, organizational characteristics may also

[7] http://www.people-press.org/2018/01/25/economic-issues-decline-among-publics-policy-priorities/

be responsible for the customized EMP adoption decisions a firm makes in response to institutional pressures common to broad groups of firms (Delmas and Toffel 2008). An overarching conclusion from this research is that in addition to time, variation in adoption exists *across* industries because of differences in institutional pressures (e.g., regulation and competition), and among firms *within* a common industry because of a firm's unique organizational characteristics and experiences.

While a considerable amount of literature has examined the drivers of EMP adoption and broadly identified the sources of variation, a comparable estimate of their importance is missing in part because most studies evaluating adoption are conducted at the firm level in one industry, where firms encounter similar regulatory rules and external stakeholder pressures (Sarkis et al 2010, Christmann 2004). Even studies with multiple industries include a narrow set of firm characteristics from a few industries. While these studies are insightful and indicate the importance of both firm and industry specific effects to EMP adoption decisions, they do not allow us to draw useful conclusions about which source of heterogeneity (time, firm or industry) is relatively more important. The importance of identifying sources of variation and estimating their relative impact is well established in management literature, where researchers have concluded that variation attributed to different sources necessitates distinct firm and regulatory responses (Misangyi et al. 2006; McGahan and Porter 1997; 2002). Extending this logic to our context, we contend that if we find that firm-specific characteristics explain a larger proportion of the variation, then tactics directed at individual firms, such as incentives, should play a central role in efforts to increase EMP adoption. Alternately, if industry attributes dominate, then tactics directed at the industry, such as regulation, should play a central role.

In this study, we focus on two inter-related issues. First, we conceptually identify distinct sources of variation in EMP adoption among firms and empirically estimate their relative importance. Based on extant literature, we recognize three sources of variation; *temporality* (variation over time), *firm*-specific choices and characteristics, and *industry* membership. Second, we review existing literature to identify individual firm characteristics and industry attributes that influence EMP adoption. We refer to these characteristics and attributes as "*strategic factors*" and subsequently test whether, and to what extent, they impact EMP adoption. Our study is primarily descriptive in nature and seeks to explain an observed phenomenon (i.e. variation in EMP adoption) using insights gleaned from existing literature. While we do not hypothesize, we outline expected relationships between strategic factors and EMP adoption. A similar approach has been used by strategy researchers (Misangyi et al. 2006; McGahan and Porter 1997; 2002).

To examine our assertions, we use panel data that spans a 12-year period from 2002 to 2013, and includes 880 firms, 258 industries, and 8 sectors which represent the broad spectrum of U.S. economic activity. To accommodate the multi-level nested data structure, we use Hierarchical Linear Modeling (HLM; Bryk & Raudenbush 1992). Empirical results show that *temporality*, *firm*, and *industry* account for 40.0%, 25.7%, and 34.3% of the aggregate variance in EMP adoption respectively. Results from the analysis of *firm* strategic factors show that firm size, profitability, available labor, and prior experience adopting management practices (such as ISO 9000, lean, TQM, and Six Sigma) support EMP adoption. Results from the analysis of *industry* strategic factors show that while regulation and competition support adoption, munificence, dynamism, and complexity hinder EMP adoption.

These results make critical theoretical and practical contributions. First, to the best of our knowledge this is the first study to identify temporality, firm-specific choices and characteristics, and industry membership as distinct sources of variation in EMP adoption and to empirically assess their relative importance. While the significant level of variation explained by industry membership (34%) suggests that initiatives targeted at industries (e.g., regulation) will play an important role in future efforts to increase adoption, the high percentage of variation explained by firm specific choices and characteristics (26%) suggests that initiatives targeted directly at firms (e.g., incentives) should also play a prominent role in those efforts. Second, by including both firm characteristics and industry attributes in one study, we integrate disparate results from numerous prior studies conducted at different units of analysis. Identifying which *firm* strategic factors support adoption is important to practitioners who desire to implement proactive environmental management strategies. Understanding which *industry* strategic factors influence adoption provides explanation for how a firm's competitive environment influences adoption. Third, our findings are more generalizable than previous studies because we evaluate a broader set of EMPs, use secondary data covering twelve years, and include numerous companies from multiple industries and sectors representing the full spectrum of U.S. economic activity. Prior studies investigated a small set of EMPs, used cross-sectional, primary data, and investigated firms in narrowly defined industries or sectors, such as furniture manufacturing (Klassen & Whybark 1999), chemicals (Christmann 2004), or automotive (Sarkis et al. 2010). Finally, the 50

EMPs included in this study encompass all aspects of environmental management and provide a broad-based instrument useful for future researchers conducting research in this area.

2.2 Literature review

Academic literature related to EMPs has grown exponentially over the last two decades. We conduct an in-depth review of this literature and highlight implications most relevant to our study. To our surprise, we find that despite numerous published articles there is no agreed upon conceptual or empirical definition of EMPs, although multiple descriptions and measurements exist. As such, we leverage the literature review to develop a definition of EMPs as "*any activity undertaken by a firm to reduce the impact of their operations, or supply chain, on the natural environment*." This definition is similar to Montabon et al.'s (2007) definition but broadened to capture firm activities other researchers view as EMPs and reflect that EMPs "pertain to diverse foci, represent different resource commitments and target a wide range of goals and objectives" (Sroufe et al. 2002).

To draw meaningful insights from continuously expanding literature, we organize our discussion of existing studies by their "thematic focus" and the "theoretical lens" used (Table 2.1). Thematically, the majority of studies focus either on the performance consequences of EMP adoption or drivers (i.e. antecedents) of EMP adoption. There is strong support for a robust and positive relationship between EMP adoption and various measures of performance, including environmental (Anton et al. 2004, Klassen & Whybark 1999, Potoski & Prakash 2005, Toffel 2005), operational (Montabon et al. 2007) and financial (Jacobs et al. 2010). However, there is less concurrence about the antecedents of EMP adoption because studies vary by whether they include factors internal or external to the firm and the unit of analysis. For instance, internal factors studied include firm size (Hofer et al. 2012, Delmas & Toffel 2008, King et al. 2005), profitability (Hofer et al. 2012), and prior experience adopting management practices (Yang et al. 2011), while external factors studied include regulation (Banerjee et al. 2003, Bansal & Roth 2000), competition (Hofer et al. 2012, Khanna & Anton 2002), uncertainty and complexity (Gatigon & Robertson 1989, Ettlie 1983). Moreover, many of these factors have been studied independently, at the firm or industry level of aggregation, making a comparison across studies challenging due to differing units of analysis.

Table 2.1 - Literature review

Thematic Focus	
Performance consequences of EMP adoption:	
Environmental Performance	Anton et al. 2004; King & Lenox 2002; Klassen & Whybark 1999; Melnyk 2003; Potoski & Prakash 2005; Toffel 2005; Zhu & Sarkis 2004
Operational Performance	Melnyk 2003; Montabon, 2007; Sroufe 2003; Zhu & Sarkis 2004
Financial Performance	Jacobs et al. 2010; King & Lenox 2002
Antecedents from Unit of Analysis of EMP Adoption:	
Firm as unit of analysis	Delmas & Toffel 2008; Hofer et al. 2012; King et al. 2005; Yang et al. 2011
Industry as unit of analysis	Ettlie 1983; Banerjee et al. 2003; Bansal & Roth 2000; Gatigon & Robertson 1989; Hofer et al. 2012; Khanna & Anton 2002
Time Trends	Delmas 2003; King et al. 2005
Theoretical Lens	
Institutional Theory (e.g. institutional pressure)	Banerjee et al. 2003; Buysse & Verbeke 2003; Henriques & Sadorsky 1996; Jennings & Zandbergen 1995; Madsen & Ulhoi 2001; Ruenda-Manzanares et al. 2008; Sarkis et al. 2010
Organizational Theory (e.g. Resource dependence, RBV)	Bansal & Roth 2000; Banerjee et al. 2003; Delmas and Toffel 2008; Gavronski et al. 2008; Gavronski et al. 2013; Khanna & Anton 2002; Paulraj 2009
Stakeholder Theory	Banerjee et al. 2003; Henriques & Sadorsky 1996; Madsen & Ulhoi 2001; Ruenda-Manzanares et al. 2008

From a “theoretical” perspective, EMP adoption is evaluated primarily through the lens of institutional, stakeholder, and organizational theories. Institutional theory emphasizes the role of social and cultural pressure on organizations, which in turn influences organizational practices and structures (Scott 1992). It suggests that firms obtain legitimacy by conforming to the dominant practices within their organizational field (DiMaggio and Powell 1983). In the context of EMPs, the institutional logic, in conjunction with stakeholder theory, suggests that firms adopt EMPs primarily in response to pressure exerted on them by various internal and external stakeholder groups, such as employees, managers, competitors, customers, investors, and regulatory agencies, among others (Sarkis et al. 2010, Ruenda-Manzanares et al. 2008, Banerjee et al. 2003, Madsen & Ulhoi 2001, Henriques & Sadorsky 1996). This view was first espoused by Jennings and Zandbergen (1995) to explain that firms in each industry adopt similar practices because regulations and regulatory enforcement, the main impetuses for EMP adoption, were similar *within* an industry. In sum, most institutional theorists agree that firms *within* an industry would be relatively similar in the adoption of EMPs, whereas firms in different industries would vary in the adoption of EMPs because they face different institutional pressures.

Other researchers (e.g. neo-institutional theorists) argue that the interpretation of institutional pressure should be contingent on an organization's characteristics because it may get transformed as it crosses organizational boundaries (Delmas & Toffel 2008). Strategy scholars agree with this assessment and use organizational theories, such as resource dependence and resource-based view, to show that firms have different organizational characteristics (e.g. resources, capabilities) and may have different needs (Bansal & Roth 2000, Banerjee et al. 2003, Gavronski et al. 2013, Gavronski et al. 2008, Paulraj 2009, Khanna & Anton 2002). These differences in resource endowments may result in firms responding differently to similar institutional and stakeholder pressures, even when interpreted objectively, leading to heterogeneity in EMP adoption among firms even *within* a common industry.

In summary, our literature review indicates that heterogeneity in EMP adoption among firms is pervasive and has several unique underlying sources. These sources can be broadly grouped into temporality, firm-specific choices and characteristics, and industry membership. However, despite a large number of studies, there is no systematic examination of the sources of variation and their relative influence on adoption. Given that our aim is to empirically estimate the relative influence of the three sources on EMP adoption, we focus our literature review on the antecedents of EMP adoption and use theory in an *ex post* manner to explain whether institutional pressures or organizational characteristics explain more or less variation in EMP adoption.

2.2.1 Sources of heterogeneity in EMP adoption

Here, we briefly outline the motivation, gleaned from literature, for including each source of variation.

Temporality: Conventional wisdom and empirical evidence indicates that EMP adoption by firms has increased significantly over time, likely because of increasing societal awareness and related regulatory requirements. For instance, ISO 14000 certificates grew from less than 20,000 in 1999 to over 250,000 in 2012 worldwide[8] (Castka & Corbett 2015). Similarly, ISO 14001 penetration in UN member countries grew from 22% to 70% between 1996 and 2006, (Delmas & Montes-Sancho 2011, p.109). Similar positive temporal trends have been observed in US firms (Su et al. 2015). Thus, time should account for a substantial portion of the observed variation in EMP adoption between firms.

Firm: Stakeholder theory posits that the only responsibility of firm managers is to serve the interests of stakeholders (Freeman 1984). The resource-based-view of the firm (RBV; Barney 1991) posits that firms realize competitive advantage by making decisions which combine resources and capabilities, which are heterogeneously distributed between firms, in unique ways. Taken together, we understand that stakeholders define success and firms realize success by making decisions which maximize existing resources and capabilities. The natural-resource-based-view of the firm (Hart 1995) builds on RBV by pointing out that competitive advantage can also be realized by combining resources and capabilities in ways which reduce a firm's impact on the natural environment, i.e. adopting EMPs. Thus, environmental stakeholders constitute a unique source of requirements and firms adopt EMPs in response to these requirements. But, while some environmental requirements are common to all firms in an industry (ex. regulation), other requirements are firm-specific, such as those emanating from investors, customers, local communities, and employees. Adoption choices made in response to these firm-specific requirements, as supported/constrained by existing resources and capabilities, should constitute a unique source of heterogeneity in EMP adoption between firms.

Industry: As explained above, institutional pressures differ across industries, and firms belonging to different industries face different regulatory pressures. Research linking EMP adoption with regulation (Bansal & Roth 2000, Lampe et al. 1991, Lawrence & Morell 1995, Post 1994, Vredenburg & Westley 1993, Marcus & Geffen 1998) and competitive intensity (Hofer et al. 2012, Marcus & Geffen 1998) clearly shows that these industry attributes impact EMP adoption. Although it is difficult to generalize the results of these studies, it is clear that industry attributes should explain some portion of the observed heterogeneity in EMP adoption.

[8] http://www.iso.org/iso/iso_survey_executivesummary.pdf, last accessed November 18, 2013

2.2.2 Strategic factors

Strategic factors are unique firm characteristics and industry attributes expected to impact EMP adoption, and as such, should help explain which specific aspects of the firm and industry contribute to variation in EMP adoption. To identify a robust set of strategic factors, we investigate both the EMP and innovation adoption literatures. We include the innovation adoption literature because EMPs are administrative and technological innovations (Damanpour 1987). The results of our review are summarized in Table 2.2. As can be seen, there is varying support for each characteristic, with firm size included in many studies and others less frequently.

Table 2.2 - Firm characteristics and industry attributes – Literature review

Cite	Adopted	Firm Characteristics: Firm size	Profitability	Prior adoption (QMS or ISO 9000)	R&D spend	Asset mgmt efficiency (sales to asset ratio)	Slack labor resources	Slack financial resources	Available knowledge resources	Innovation experience	Industry Attributes: Competition	Uncertainty	Complexity	Munificence or industry growth	Dynamism	Regulation
EMP Adoption Literature (empirical)																
Hofer et al. (2012)	EMPs	✓+	✓-								✓					
Yang et al. (2011)	EMPs	✓		✓+												
Delmas & Toffel (2008)	EMPs	✓+														
Ruenda-Manzanares et al. (2008)	EMPs	✓										✓+	✓-	✓		
Zhang et al. (2008)	EMPs	✓+	✓													
King et al. (2005)	EMPs	✓+		✓												
Christmann (2004)	EMPs	✓														
Anton et al. (2004)	EMPs				✓	✓-										
Buysse & Verbeke (2003)	EMPs	✓+														
Khanna & Anton (2002)	EMPs				✓+	✓-					✓					
King & Lenox (2001)	EMPs	✓+		✓+												
Klassen (2001)	EMPs	✓														
Christmann & Taylor (2001)	EMPs	✓+		✓												
Klassen (2000)	EMPs	✓+														
Sharma (2000)	EMPs	✓+														
Aragon-Correa (1998)	EMPs	✓														
Innovation Adoption Literature (theoretical + empirical)																
Jeyoraj et al. (2006)	IT	✓+					✓	✓			✓					
Frambach & Schillewaert (2002)		✓									✓					
Damanpour & Gopalakrishnan (1998)															✓	
Grover et al. (1997)	Tech and admin IT	✓+	✓													
Capon et al. (1992)	Mfg products				✓+									✓+		✓
Damanpour (1991)	Broad (meta-analysis)							✓	✓+							
Gatigon & Robertson (1989)	High-tech										✓+	✓				
Dewar & Dutton (1986)	Footwear/food processing	✓+							✓+							
Hambrick & McMillon (1985)	Mfg products				✓+					✓+				✓+		
Ettlie (1983)	Food industry	✓+										✓+				
Kimberly & Evanisko (1981)	Healthcare	✓+									✓+					

2.2.2.1 Firm level strategic factors

<u>Firm size</u>: The influence of firm size on firm behavior, performance, and structure is pervasive and has been identified in relation to the adoption of administrative and technological innovations in industries as diverse as hospitals (Moch 1976), education (Baldrige & Burnham 1975), and manufacturing (Ettlie et al. 1984). While theoretical arguments supporting either a negative or positive relationship are found in literature, empirical evidence overwhelmingly supports a positive association between size and adoption. Authors have noted that structural inertial forces associated with bureaucracies in large organizations (Hannan & Freeman 1984) negatively impact adoption and the inertial effect of size is found to be more prevalent in manufacturing industries than service industries (Gopalakrishnan & Damanpour 1997). However, large size also implies availability of both capital and human resources, attributes expected to be positively related to EMP adoption (see discussion below). In addition, relative to EMPs in particular, larger firms may be more visible to the public and thus experience greater pressure to adopt (Brammer & Millington 2006, Bowen 2000). Given the overwhelming support for a positive association between firm size and adoption, we expect to see a positive relationship between firm size and EMP adoption.

<u>Profitability</u>: The adoption of EMPs may require significant financial investment (Hart & Ahuja 1996, Tate et al. 2010) and is associated with uncertain short- and long-term financial returns (King & Lenox 2001, 2002). Due to greater financial stability over time, more profitable firms should better positioned to make the required financial investments and withstand the uncertain financial returns associated with EMP adoption. Thus, we expect to see a positive relationship between profitability and EMP adoption.

<u>Financial resource availability (financial slack)</u>: Beyond having the financial stability to absorb uncertain investment returns over time, it is reasonable to posit that slack financial resources may be required to successfully implement EMPs. In this context, slack is defined as "resources an organization has beyond what it minimally requires to maintain operations" (Damanpour 1991). Such resources have been shown to support the implementation of organizational innovation (Damanpour 1991, Jeyaraj et al. 2006, Bourgeois 1981, Chakravarthy 1982), among other benefits. Since capital investment is required for the adoption of some EMPs (Hart & Ahuja 1996, Tate et al. 2010), we expect financial slack to be positively related to EMP adoption.

<u>Labor resource availability (labor slack)</u>: Available and skilled labor is also required to implement EMPs, such as the labor needed to manage process and technical changes, conduct

risk assessments and training, manage scorecards and performance, and participate in extra-organizational partnerships. As such, the presence of readily available labor should be positively associated with EMP adoption.

Quality management system (QMS) adoption: Evidence suggests that prior adoption of a QMS, such as lean, TQM or Six Sigma, will be positively associated with the adoption of EMP's. Quality improvement professionals leverage continuous improvement and process improvement techniques to eliminate system waste harmful to quality performance. These same approaches are used by environmental practitioners to reduce system waste harmful to the natural environment. While their underlying motive for eliminating waste may be different, to improve system quality and reduce environmental impact respectively, the improvement methods, program goals, and program benefits overlap. Due to such complementarities, or possibly because of a shared culture focused on eliminating waste, implementing a QMS may accelerate efforts to improve environmental performance through the adoption of EMPs. In fact, Yang et al. (2011) find such a relationship between the implementation of lean and EMP adoption.

ISO 9000 adoption: We also expect that prior implementation of a management standard, such as ISO 9000, will be positively associated with EMP adoption. The set of EMPs a firm adopts collectively functions as a firm's environmental management system (Anton et al. 2004, Khanna & Anton 2002, Montabon et al. 2000). Environmental management systems (EMSs), such as ISO 14000, are tasked to identify obstacles to better environmental performance and implement remedies. Researchers have shown that prior adoption of ISO 9000 is positively associated with ISO 14000 adoption. They explain this relationship by noting that prior experience with ISO 9000 removes uncertainty related to the relevance and value of ISO 14000 (Albuquerque et al. 2007) and that similar structures, motives, and economies of scope between the two standards explain the positive relationship (Delmas and Montiel 2008). Given the proven relationship between ISO 9000 and ISO 14000, we expect to see a positive relationship between prior ISO 9000 adoption and current EMP adoption because ISO 9000 adoption removes uncertainty associated with, and value derived from, implementing an EMS comprised of adopted EMPs.

2.2.2.2 Industry level strategic factors

Environmental Risk: Production processes are relatively similar within an industry and different across industries. In fact, such similarities and differences form the basis of the Standard Industrial Classification (SIC) system used extensively by researchers to define industries (King et al. 2005, King & Lenox 2001). Given the logical connection between production process type and environmental impact, the risk a firm presents to the natural environmental should be relatively homogenous within an industry and heterogeneous between industries. For instance, firms in mining and chemical industries pose a greater pollution risk to the air, water and soil than firms in automotive or food industries. Environmental risk garners attention from environmental stakeholders, such as regulators and NGO's, who in turn exert influence to manage emissions through legislation, such as the Clean Air Act and the Clean Water Act. Regulatory pressure has been shown to positively impact EMP adoption (Bansal & Roth 2000, Lampe et al. 1991, Khanna & Anton 2002). As such, environmental risk should be positively related to EMP adoption.

Competition: The relationship between competition and EMP adoption has mixed support in the literature. Hofer et al. (2012) find that competitive rivalry between market leaders drives increased EMP adoption. Gatignon and Robertson (1989) find that firms in highly competitive industries may adopt to "keep up" with their competition to avoid a competitive disadvantage. However, other investigations have been inconclusive (Khanna & Anton 2002). Given this ambiguity, the relationship between competition and EMP adoption is not clear. Because we include other potential confounding factors in our model, such as environmental risk, our study should be able to more accurately assess the effect of competition on EMP adoption.

Environmental uncertainty: Uncertainty in the firm's external competitive environment has been shown to impact firm strategic (Keats & Hitt 1988, Kim & Lee 1988, Ward & Duray 2000) and operational decisions (Anand & Ward 2004). It is reasonable to extend this logic and argue that environmental uncertainty may influence EMP adoption decisions as well. In this study, we examine three dimensions frequently used to conceptualize environmental uncertainty: munificence, dynamism, and complexity (Dess & Beard 1984).

Munificence is defined as the extent to which an environment can support sustained growth. Industry growth supports the generation of financial slack (Cyert & March 1963), which in turn supports the implementation of organizational innovation, among other benefits (Bourgeois 1981, Chakravarthy 1982). Damanpour (1987) empirically tests this relationship and finds a significant positive relationship with technological innovation, but not with administrative or ancillary innovation, which were positive but not statistically significant. This result seems logical as technical innovations require greater capital investments than administrative or ancillary innovations. Relative to EMPs, while the implementation of many EMPs requires only available labor, others require some level of capital investment. As such, we expect to see a positive relationship between industry munificence and EMP adoption.

Dynamism refers to the degree of instability in an industry, resulting from the rate and unpredictability of change in products, technologies, and demand for products (Dess & Beard 1984). Dynamism increases uncertainty in decision making and has been shown to support competitive strategies based on differentiation (Ward & Duray 2000). Thus, to the extent that an industry is predominately populated by firms pursuing differentiation strategies, and to the extent that EMP adoption can enhance that differentiation, a positive relationship between dynamism and EMP adoption will be expected. In all other industries, we would not expect to see a relationship between dynamism and EMP adoption.

Complexity refers to heterogeneity in the number, diversity, and distribution of task-environment elements for an industry (Aldrich 1979, Dess & Beard 1984). In this conceptualization, increased complexity implies an increase in an organizational requirement to process information. Thus, to the extent that EMP's support information processing, a positive association would be expected between industry complexity and EMP adoption. Unfortunately, as a whole, EMP's do not support information processing. While some EMP's, such as the creation of an environmental management team or increased environmental training, may improve the ability to process certain environmental decisions, such decisions constitute an insignificant portion of total decision making within an organization. As such, we would not expect industry complexity to be associated with EMP adoption.

2.3 Data and Research Method

2.3.1 Data and sample

We investigate EMP adoption in U.S. firms using data from several sources, including Compustat and two Thomson Reuter's databases, ASSET4 and Worldscope. ASSET4, used previously in related academic research (Ioannou & Serefeim 2012, Cheng et al. 2014, Eccles et al. 2014), provides annualized data on EMP adoption (our dependent variable), ISO 9000 adoption, and quality management system (QMS) adoption. Worldscope, a global financial and economic database used previously by researchers (Hawn & Ioannou, 2016; Ioannou and Serefeim, 2012), is used to develop several firm measures, including size, profitability, and resource availability (financial and labor). Compustat provides industry data used to develop measures of munificence, dynamism, complexity, and competition and data from First for Sustainability, an initiative of the International Finance Corporation, is used to develop a measure of industry environmental risk.

The data covers the years 2002-2013. Because new firms enter the panel each year, the panel is unbalanced. The unit of analysis is firm-year. We evaluate only U.S. firms to avoid potential heterogeneity in EMP adoption due to differences in the way countries may value environmental issues, and public firms, because financial information for such firms is federally mandated and readily available. Industries are defined by 4-digit SIC codes.[9] Our final sample includes 880 firms from 258 industries and 8 sectors representing the full spectrum of U.S. economic activity.

2.3.2 Research method

We use hierarchical linear modeling (HLM) to evaluate our research hypotheses.[10] In our data, measures of EMP adoption over time are uniquely nested within firms, which are uniquely nested within industries. The nested structure implies that observations across levels are not independent, i.e. while EMP adoption over time is likely to be more similar within a specific firm, it may vary systematically across firms within a common industry. In essence, our data has three hierarchically embedded levels and HLM is particularly suited to analyze such a data structure. It allows us to fully address non-independence between levels and at the same time assesses the relative importance of each level (Misangyi et al. 2006, Bryk & Raudenbush 1992). Other approaches used to analyze nested data include variance components analysis (VCA) and analysis of variance (ANOVA). However, these methods assume independence between observations, an assumption violated in our data. HLM has been used in diverse settings, such as education (Lee 2000), healthcare (McDermott & Stock 2011) and business (Misangyi et al. 2006), and our empirical approach draws heavily upon these studies.

2.3.3 Variable measurement

2.3.3.1 Dependent Variable

EMP adoption measures the extent of a firm’s environmental management activity and is operationalized as a ratio of the EMPs a firm *adopts* in a given year to the number of EMPs the firm *could have* adopted. An EMP is defined as any “*activity undertaken by a firm to reduce the impact of their operations, or supply chain, on the natural environment.”* This definition is

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[9] https://www.osha.gov/pls/imis/sic_manual.html
[10] All analyses were completed using R, version 3.3.1
.

similar to Montabon et al.'s (2007) definition, but slightly more inclusive to reflect the views of other authors who consider EMPs to include activities beyond his definition (e.g. Hofer et al. 2012, Anton et al 2004, Klassen 2001). Prior studies have operationalized EMP adoption using a single item, such as ISO 14000 (Delmas and Toffel 2008, King & Lenox 2001), a single, multi-item construct (Ruenda-Manzanares et al. 2008, Christmann 2004), several multi-item constructs (Sarkis et al. 2010, Klassen 2001) or a count of environmental management practices (Anton et al. 2004, Khanna & Anton 2002), where the largest set of EMPs included 33 practices. We calculate a ratio because it effectively captures the broad differences in environmental activity across firms, while supporting accurate comparisons between firms. Our full EMP evaluation set consists of 50 practices which capture the wide variety of activities firm undertake to manage their environmental impact. In developing this set, we identified practices which matched our adopted definition and had limited or no missing data. The number of EMPs a firm *could have* adopted was established by 4-digit SIC industry. If at least one firm in an industry adopted a particular EMP, it was included in the set of available EMPs for all firms in that industry.

2.3.3.2 Sources of heterogeneity

Temporality: Captures the ability of time to explain heterogeneity in EMP adoption between firms. Because temporal variation could include both longitudinal year-over-year changes and cross-sectional within-year changes, we estimate the effect of each of these "temporal" effects separately (Misangyi et al. 2006). We label year-over-year effect as "**time**", and within-year fluctuation in adoption as "**year**".

Firm: Captures the explanatory power of firm-specific choices, made in response to stakeholder pressure and supported/constrained by available resources and capabilities, to explain heterogeneity in EMP adoption between firms. Firm actions, i.e. EMP adoption, are measured at the corporate level because decision making relative to EMP adoption is often the result of corporate directives.

Industry: Captures the ability of industry attributes to explain heterogeneity in EMP adoption between industries. We operationalize industry using 4-digit SIC codes, an approach shown by previous environmental researchers to capture unique aspects of the industry which may be relevant to EMP adoption, such as regulation and competition (King et al. 2005, King & Lenox 2001).

2.3.3.3 Firm level strategic factors

Firm size: We measure firm size as the natural log of net sales (Hofer et al. 2012, Delmas & Toffel 2008). As robustness checks, we also measure firm size as the natural log of total employees (King et al. 2005, King & Lenox 2001) and natural log of total assets (Zhang et al. 2008). To control for fundamental differences in firm size across industries, we normalize each variable in a given year across all firms in the same industry (Modi & Mishra 2011).

Profitability: We measure profitability as the natural log of return on assets (Zhang et al. 2008). As a robustness check, we also measure profitability as the natural log of return on sales (Hofer et al. 2012). To control for fundamental differences in profitability across industries, we normalize each variable in a given year across all firms in the same industry (Modi & Mishra 2011). Since there could be a delay in how profitability influences EMP adoption, i.e. profitability in period t-1 may impact EMP adoption in period t, we evaluate both a lagged and unlagged relationship. Both approaches produce similar results. We present only the lagged results in result tables.

Financial resource availability (financial slack): Measures financial assets readily available for investment in EMP adoption. This conceptualization of financial slack has been called *available* or *unabsorbed* slack by researchers and operationalized using the current ratio, i.e. total assets/total liabilities (Chandler 2008, Geiger & Cashen 2002, Singh 1986). As a robustness check, we also conceptualize financial slack as *recoverable* or *absorbed* slack, which are excess costs of the firm that can be utilized to take advantage of new opportunities (Bourgeois & Singh 1983). It is measured as selling, general and administrative expense (SG&A) divided by net sales (Bourgeois & Singh 1983, Gieger & Cashen 2002, Bromiley 1991). To control for fundamental differences in capital requirements across industries, we normalize each variable in a given year across all firms in the same industry (Modi & Mishra 2011).

Labor resource availability (labor slack): Measures labor resources readily availability to support EMP adoption. This firm characteristic has been termed labor intensity in the literature and operationalized as total employees/total assets (Dewenter & Malatesta 2001) and total employees/net sales (Dewenter & Malatesta 2001, Norton 1988, Trostel & Nichols 1982). We include the latter operationalization in result tables but evaluate the former as a robustness check. To control for fundamental differences in labor requirements across industries, we normalize each variable in a given year across all firms in the same industry (Modi & Mishra 2011).

Quality Management System (QMS) adoption: Measures whether the firm has adopted and is actively using lean, total quality management (TQM), or Six Sigma. It is operationalized as a binary measure (0 = no, 1 = yes). Since we expect a delay in the impact of QMS adoption on EMP adoption, we match QMS adoption in period t-1 with EMP adoption in period t.

ISO 9000 adoption: Measures whether the firm has implemented and is using ISO 9000. It is operationalized as a binary measure (0 = no, 1 = yes). Since we expect a delay in the impact of ISO 9000 adoption on EMP adoption, we match ISO 9000 adoption in period t-1 with EMP adoption in period t.

2.3.3.4 Industry level strategic factors

Environmental risk: Measures the level of risk an industry presents to the natural environment, and by proxy, the level of attention an industry receives from environmental stakeholders, such as regulators and NGO's. It is operationalized as low/medium/high by using the environmental and social risk assessments completed by First for Sustainability (FFS), an initiative of the International Finance Corporation.[11] FFS completes these assessments to support financial institutions in managing environmental and social risks associated with their investments. The assessments are completed at a macro-industry level and are mapped manually by the authors to the industries used in the current study.

Competition: Measures the relative level of competition in an industry and is operationalized using the Herfindahl-Hirschmann Index (Hofer et al. 2012, Khanna & Anton 2002). High industry concentration (high HHI) indicates that market leadership (share) is concentrated within a relatively small group of firms and implies *low* competitive rivalry.

Munificence: Munificence is defined as the extent to which an industry can support sustained growth. It is operationalized per Keats & Hitt (1988), using gross revenue as a measure of growth and calculated for the 5-year period immediately preceding, and including, the year of analysis.

Dynamism: Dynamism is the degree of instability in an industry, such as in products, technologies, and demand for products, that is difficult to predict (Dess & Beard 1984). It is operationalized per Keats & Hitt (1988), using volatility in gross revenue and calculated for the 5-year period immediately preceding, and including, the year of analysis.

C*omplexity:* represents the heterogeneity in the number, diversity, and distribution of task-environment elements for an industry (Aldrich 1979, Dess & Beard 1984). It is operationalized per Keats & Hitt (1988) and calculated for the 5-year period immediately preceding, and including, the year of analysis.

[11] See www.firstforsustainability.org for the actual assessments.

2.3.4 Descriptive statistics

Descriptive statistics and correlations are provided in Tables 2.3 and 2.4. In examining the correlations, we find that measures of firm size, profitability, labor availability, and prior adoption of management practices are positively correlated with EMP adoption. This suggests that large and more profitable firms, and firms with available labor and prior adoption experience, are likely to adopt more EMPs. In contrast, slack financial resources are not correlated with EMP adoption, suggesting that available capital may not be a necessary prerequisite to adoption. Relative to industry attributes, we see that environmental risk, competition, and munificence are positively correlated, and complexity is negatively correlated, with EMP adoption. The results suggest that adoption may increase in industries which pose a greater risk to the environment, are more competitive, are more munificent, and/or are less complex.

Table 2.3 - Descriptive statistics

Label	Description	Measurement	Min	Max	Mean	St. Dev.
Dependent variable						
EMP	EMP Adoption	Fraction of applicable EMPs adopted by a firm in time period *t*, for firm *i*, in industry *j* and sector *k*	0.00	0.98	0.23	0.25
Firm characteristics						
firmSIZE_1	Net sales	Natural log of net sales/revenues	3.91	19.98	14.95	1.69
firmSIZE_2	Total employees	Natural log of total employees	2.95	14.60	8.86	1.79
firmSIZE_3	Total assets	Natural log of total assets	4.86	20.84	15.53	1.63
firmPRFT_1	Return on Assets	Return on assets (prior year)	-84.96	88.87	6.73	9.52
firmPRFT_2	Return on Equity	Return on equity (prior year)	-372.45	643.55	15.78	43.66
firmPRFT_3	Operating Margin	Operating margin (prior year)	-270.54	350.34	15.57	18.34
firmCAP_1	Available slack	Current ratio (current assets/current liabilities)	0.28	20.50	2.00	1.50
firmCAP_2	Recoverable slack	SG&A/annual sales	0.15	6.49	0.25	0.25
firmLBR	Labor Intensity	Total employees/total assets	0.00	0.06	0.00	0.01
firmISO	ISO 9000 adoption	Adoption of ISO 9000 (prior year)	0	1	0.20	0.33
firmQMS	QMS adoption	Adoption of a Quality Management System (prior year)	0	1	0.17	0.32
Industry attributes						
indRISK	Environmental risk	Environmental & social risk connected to an industry	0	2	0.91	0.92
indCOMPT	Competition	Industry concentration (high concentration = low competition)	117.89	7394.04	1694.46	1199.57
indMUN	Munificence	Ability of industry to support sustained growth	0.62	1.55	1.05	0.07
indDYN	Dynamism	Unpredictability of environmental change	1.00	1.36	1.03	0.02
indCOMPX	Complexity	Heterogeneity in task environment elements	0.08	4.09	0.98	0.29

Table 2.4 - Correlations for all variables used in the study

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Dependent variable																		
1	EMP	1																
Firm characteristics																		
2	firmSIZE_1	0.50*	1															
3	firmSIZE_2	0.42*	0.78*	1														
4	firmSIZE_3	0.40*	0.86*	0.55*	1													
5	firmPRFT_1	0.08*	0.16*	0.14*	0.05	1												
6	firmPRFT_2	0.06*	0.09*	0.07*	0.02	0.23*	1											
7	firmPRFT_3	0.09*	0.11*	0.02	0.07*	0.13*	0.09*	1										
8	firmCAP_1	0.12	0.36*	0.28*	0.35*	0.03	-0.02	-0.07*	1									
9	firmCAP_2	0.10	0.29*	0.12*	0.20*	-0.19*	-0.07*	-0.31*	0.22*	1								
10	firmLBR	0.08*	0.05*	0.6*	-0.34*	0.09*	0.05*	-0.02	0.02	0.06	1							
11	firmISO	0.24*	-0.06*	-0.03*	-0.10*	0.05*	0.02*	0.03*	0.19*	-0.04	0.06	1						
12	firmQMS	0.32*	0.11*	0.14*	0.08*	0.03*	0.03*	0.03	0.01	-0.06	0.09	0.24*	1					
Industry attributes																		
13	indRISK	0.21*	-0.02	-0.31*	0.07*	-0.09	-0.05*	-0.02	0.10*	-0.14*	-0.42*	0.22*	0.20*	1				
14	indCOMPT	0.05*	0.10*	0.24*	-0.05*	0.04*	0.02	0.01	-0.03*	-0.06*	0.32*	0.05	0.10	-0.20*	1			
15	indMUN	0.09*	0.01	-0.06*	-0.01	0.12*	0.08*	-0.02	0.02	0.01	-0.06*	0.02*	-0.05*	0.09*	-0.06*	1		
16	indDYN	-0.00	-0.07*	-0.21*	-0.02	-0.07*	-0.03*	0.02	0.02	-0.16*	-0.21*	0.08	0.02	0.23*	0.07*	-0.32*	1	
17	indCOMPX	-0.02*	-0.04*	0.02	-0.05*	0.03	-0.03*	0.03	0.04*	0.02	0.07*	0.06*	0.01	-0.04*	0.16*	-0.20*	0.03	1

* $p < 0.05$

2.4 Data Analysis and Results

We conduct our investigation in two parts using HLM; (1) a multilevel analysis and (2) a strategic factor analysis. In the multilevel analysis, we quantify the contribution of temporality (year + time), firm-unique choices and characteristics, and industry membership to explaining heterogeneity in EMP adoption. In the strategic factor analysis, we explore the relationship between specific firm characteristics and industry attributes, and EMP adoption.

2.4.1 Multilevel analysis

Following the approach taken by Misangyi et al. (2006), we conduct this analysis in two steps. We first partition observed variation in EMP adoption into the three nested levels of the data hierarchy, i.e. temporal, firm, and industry (Levels 1, 2, and 3 in HLM vernacular) and then partition the temporal (Level 1) variation into its constituent parts, i.e. "time" (year-over-year component) and "year" (within-year component). The final analysis thus allocates variation in EMP adoption across four unique sources; year, time, firm, and industry.

In step one, we estimate a series of 'unconstrained' (no predictors) equations. In the Level 1 analysis, firm EMP adoption at each time period is modeled as a function of mean EMP adoption for the firm across all time periods, plus a random error:

$$Y_{tij} = \Pi_{0ij} + e_{tij} \tag{1a}$$

where the indices t, i, and j denote time, firm, and industry respectively. There are
- $t = 1, 2, \ldots, T_{ij}$ time periods within firm i and industry j;
- $i = 1, 2, \ldots, I_j$ firms within industry j;
- $j = 1, 2, \ldots, J$ industries in the sample; and

where Y_{tij} is EMP adoption in period t, for firm i, within industry j; Π_{0ij} is the mean EMP adoption across the entire panel for firm i within industry j; and e_{tij} is the time-level random error, which captures variance *across time*. The model assumes e_{tij} is normally distributed with a mean of 0 and a variance of σ^2.

At Level 2, mean EMP adoption over time for a specific firm, Π_{0ij} (from equation 1a), is modeled as the dependent variable, varying randomly around some industry mean:

$$\Pi_{0ij} = \beta_{00j} + r_{ij} \tag{1b}$$

where β_{00j} is mean industry adoption for industry j. The error term, r_{ij}, represents variation *between firms* within a specific industry and is assumed to be normally distributed with a mean of 0 and a variance of τ_{Π}.

At Level 3, mean EMP adoption for an industry, β_{00j} (from equation 1b), is modeled as the dependent variable, varying randomly around the grand mean:

$$\beta_{00j} = \gamma_{000} + \mu_j \tag{1c}$$

where γ_{000} is the grand mean for EMP adoption. The error term, μ_j, represents variation *between industries* and is assumed to be normally distributed with a mean of 0 and a variance of τ_{β}.

After performing chi-square tests to establish that σ^2, τ_{Π}, and τ_{β} are statistically significant, we calculate the contribution of each source to explaining heterogeneity in EMP adoption as follows;

(1) *temporality* = $\sigma^2/(\sigma^2 + \tau_{\Pi} + \tau_{\beta})$
(2) *firm* = $\tau_{\Pi}/(\sigma^2 + \tau_{\Pi} + \tau_{\beta})$
(3) *industry* = $\tau_{\beta}/(\sigma^2 + \tau_{\Pi} + \tau_{\beta})$

In <u>step two</u>, we partition temporal variation into '*time*' and '*year*' components by incorporating year dummies in the temporal level of analysis as shown in equation 2.

$$Y_{tij} = \Pi_{0ij} + \Pi_{1ij}(\text{Year})_{1ij} + e_{tij} \tag{2}$$
$$\Pi_{0ij} = \beta_{00j} + r_{ij}$$
$$\beta_{00j} = \gamma_{000} + \mu_j$$

where Π_{1ij} represents Year effects and Year is a matrix of dummy variables coded for each year in the study for firm i within each industry j. Π_{0ij} now represents mean EMP adoption (across time) for firm i within industry j, *after* controlling for the effect of Year, and e_{tij} is the variance across time remaining after controlling for Year effects. This revised model assumes e_{tij} is normally distributed with a mean of 0 and a variance of $\tau_{\Pi\Pi}$. β_{00j}, γ_{000}, r_{ij}, and μ_j, are all as described previously. After estimating equation 2, we calculate the variance explanation attributable to '*year*' as; $\sigma^2 - \tau_{\Pi\Pi}/(\sigma^2 + \tau_{\Pi} + \tau_{\beta})$. We then calculate the variance explanation attributable to '*time*' by subtracting '*year*' from the total *temporal* variation observed in the unconstrained model, i.e. time (%) = temporal (%) - year (%).

The results from estimating Equations 1a – 1c are presented in top panel of Table 2.5. We find that temporality accounts for 40.0% of the total observed variation in EMP adoption, whereas firms and industries account for 25.7%, and 34.3% respectively. Our analysis using

Equation 2 shows that 'year' and 'time' account for 8.6% and 31.4% of the total temporal variation respectively. The summarized results are presented in bottom panel of Table 2.5.

Table 2.5 - Allocating variance in EMP adoption using multi-level analysis[a]

	Variance		d.f.	Chi-sq
Unconditional Model				
Level 1 variance (across time)	0.0291			
Level 2 variance (between firms)	0.0187	***	879	5728.9
Level 3 variance (between industries)	0.0249	***	257	553.8
Percentage of total variance across time	40.03%			
Percentage of total variance between firms	25.72%			
Percentage of total variance between industries	34.25%			
Model Incorporating Year Effects at Level 1				
Level 1 variance (across time)	0.0046			
Level 2 variance (between firms)	0.0225	***	879	4609.1
Level 3 variance (between industries)	0.0261	***	257	429.9
Total variance explained by year effects	8.65%			

[a] Significant at *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.1$

Variance explained (by category)[a]

Time	31.4%	(28.8%)
Year	8.6%	(15.1%)
Firm	25.7%	(26.0%)
Industry	34.3%	(30.1%)

[a] Importance of effects may not be linearly related to the percentage of variance explained. As such, we compute relative importance using the square roots of the variance estimates following Brush and Bromiley (1997) approach. The results are provided in brackets.

2.4.2 Strategic factor analysis

We next explore which theoretically relevant firm and industry level strategic factors influence EMP adoption. Determining into which HLM equation 1(a) – 1(c) each strategic factor should be entered is a function of whether the strategic factor represents a firm characteristic or an industry attribute and whether it varies over time, varies cross-sectionally (across firms or industries), or varies both over time and cross-sectionally. To determine whether the strategic factor varies over time, cross-sectionally or both, we follow Misangyi et al. (2006) and use inter-class correlation

(ICC). ICC is computed as the ratio of cross-sectional variance to total variance, with total variance being the sum of variance over time and cross-sectional variance (James 1982, Bleise 2000). If a strategic factor varies primarily over time (i.e. low ICC score), we refer to it as "transient" and enter into equation 1(a). If a strategic factor displays primarily cross-sectional variance (i.e. high ICC score), we refer to it as "stable" and enter it into either equation 1(b) or 1(c), depending on whether it represents a firm characteristic or industry attribute respectively. If a strategic factor exhibits *both* transient and stable variation (moderate ICC score), it is entered into equation 1(a) *and* either 1(b) or 1(c). To classify strategic factors as transient, stable or both, we use the same cutoffs for ICC scores as previous researchers: variables with ICC scores of 0.10 or less are treated as transient, 0.70 and above as stable, and between 0.10 and 0.70 as both (Misangyi et al. 2006). Results from the ICC analysis are provided in Table 2.6, where the last column shows how each factor was included within the strategic factor analysis.

Table 2.6 - Transient and stable variation (ICC analysis)

	Variance over time (A)[1]	**Cross-sectional variance (B)[2]**	**ICC[3] (B/A+B)**	**Factor type[4]**
Firm characteristics				
firmSIZE_1	75.054***	28.875***	0.278	Both
firmPRFT_1	11.254***	7.384***	0.395	Both
firmCAP_1	3.891+	27.850***	0.877	Stable
firmLBR	7.379*	29.455***	0.800	Stable
firmISO	0.234**	0.801***	0.774	Stable
firmQMS	0.218**	0.699***	0.763	Stable
Industry attributes				
indRISK	0.014	55.576***	0.999	Stable
indCOMPT	0.010**	0.810***	0.987	Stable
indMUN	0.483***	0.108***	0.182	Both
indDYN	0.015***	0.013***	0.464	Both
indCOMPX	0.525***	1.794***	0.774	Stable

[a] Significant at *** p < 0.001; ** p < 0.01; * p < 0.05; + p < 0.1; p-values are based on chi-square distribution
[1]Variation in the subject variable *across the years* in the panel (Misangyi et al. 2006)
[2]Variation in the subject variable *within year*, across the aggregate level of analysis (Misangyi et al. 2006)
[3]Inter-class correlation analysis (James 1982, Bleise 2000)
[4]Both = Stable & Transient.

The following equations summarize the prior discussion and are evaluated using HLM to complete the strategic factor analysis:

$$Y_{tij} = \Pi_{0ij} + \Pi_{1ij}(\text{firm\_SIZE}) + \Pi_{2ij}(\text{firmPRFT}) + \Pi_{3ij}(\text{indMUN})$$

$$+ \Pi_{4ij}(\text{Dynamism}) + e_{tij} \tag{3a}$$

$$\Pi_{0ij} = \beta_{00j} + \beta_{01j}(\text{firm\_SIZE}) + \beta_{02j}(\text{firmPRFT}) + \beta_{03j}(\text{firmCAP}) + \beta_{04j}(\text{firmLBR}) + \beta_{05j}(\text{firmISO}) + \beta_{06j}(\text{firmQMS}) + r_{ij} \tag{3b}$$

$$\beta_{00j} = \gamma_{000} + \gamma_{001}(\text{indMUN}) + \gamma_{002}(\text{indDYN}) + \gamma_{003}(\text{indCOMPX}) + \gamma_{004}(\text{indCOMPT}) + \gamma_{005}(\text{indRISK}) + \mu_j \tag{3c}$$

In this model, the intercept of equation 3a, Π_{0ij}, represents mean adoption for firm i within industry j, adjusted for the effect of time-level predictors of EMP adoption. The intercept of equation 3b, β_{00j}, represents mean industry adoption for industry j, adjusted for the effect of firm-level predictors of EMP adoption. The intercept of equation 3c, γ_{000}, represents the grand mean, adjusted for the effect of industry-level predictors of EMP adoption. Y_{tij} is as described previously. Each level of analysis also has its own unique random error term, as before: e_{tij} represents *across-time* residual; r_{ij} represents *across-firm* residual; and μ_j represents *across-industry* residual.

Results from estimating Equations 3a – 3c are provided in Table 2.7, where each section represents a level in the nested hierarchy and shows how strategic factors at that level explain variation in EMP adoption at that level. The columns show the incremental change as blocks of factors are entered in a stepwise manner. For ease, we interpret only the coefficients of the complete model provided in Column 3. The first section (Level 1) shows which *transient* factors explain variation in EMP adoption. The second section (Level 2) shows which *stable firm* factors explain variation in EMP adoption. The third section (Level 3) shows which *stable industry* factors explain variation in EMP adoption.

Table 2.7 - Strategic factor analysis

Model	1			2			3		
Level 1 (Temporal)									
(Intercept)	0.22	(0.01)	***	0.18	(0.01)	***	0.26	(0.02)	***
firmSIZE_1	0.13	(0.00)	***	0.13	(0.01)	***	0.14	(0.01)	***
firmPRFT_1	0.01	(0.00)	+	0.00	(0.00)		0.00	(0.00)	
indMUN	-0.44	(0.05)	***	-0.47	(0.05)	***	-0.44	(0.06)	***
indDYN	-0.24	(0.16)		-0.30	(0.15)	*	-0.24	(0.12)	*
Level 2 (Firm)									
firmSIZE_1				0.04	(0.01)	***	0.04	(0.01)	***
firmPRFT_1				0.01	(0.00)	*	0.01	(0.00)	*
firmCAP_1				0.00	(0.00)		0.00	(0.00)	
firmLBR				0.02	(0.00)	***	0.02	(0.00)	***
firmISO				0.08	(0.01)	***	0.06	(0.01)	***
firmQMS				0.22	(0.01)	***	0.14	(0.01)	***
Level 3 (Industry)									
indRISK							0.06	(0.00)	***
indCOMPT							0.00	(0.00)	***
indMUN							-0.40	(0.10)	***
indDYN							-1.45	(0.31)	***
indCOMPX							-0.08	(0.02)	***
Variance Components									
Level 1(Time)		0.03	***		0.03	***		0.03	***
Level 2(Firm)		0.02	***		0.02	***		0.02	***
Level 3(Industry)		0.02	***		0.02	***		0.02	***
Sample Size (N)		7152			7152			7152	
F-Statistic		301.3	***		192.1	***		143.2	***

Significant at *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; + $p < 0.1$; p-values are based on chi-square distribution. Robust standard errors in parentheses

Firm and industry variables are aggregated at the firm and industry level, respectively, before entering the model. Temporal level variables are not aggregated.

Level 1 results show that firm size is positively associated, and industry munificence is negatively associated, with EMP adoption over time. These results imply that increases in firm size and decreases in industry munificence over time are associated with increases in EMP adoption. Level 2 results show that with the exception of capital availability (firmCAP_1), all firm characteristics are positively associated with EMP adoption. Level 3 results show that industry environmental risk and competition are positively associated, and munificence, dynamism, and complexity are negatively associated, with EMP adoption. With the exception of the negative industry relationships, results are generally aligned with our expectations, as discussed previously. We discuss these results further in the Discussion section.

2.4.3 Post hoc analysis

Prior researchers have shown that EMPs can vary in purpose and performance impact (Klassen & Whybark 1999, Montabon et al. 2007). Such differences may impact adoption decisions and could mean that conclusions depend on the type of EMP. We thus repeat our multilevel analyses by type of EMP. To capture and isolate the impact of these differences in past research studies, researchers created EMP categorization schemes. Examples include whether the EMP addresses pollution prevention, pollution control or product stewardship (Hart 1995, Bansal 2005), addresses pollution prevention, pollution control or a management system (Klassen & Whybark 1999), or whether it is directed externally or internally (Matten & Moon 2008). One useful scheme that has been used in prior research categorizes EMPs as operational, tactical or strategic (Montabon et al. 2007, Hofer et al. 2012). Operational practices are internally focused and generally pertain to firm operations. Tactical practices fall between operational and strategic practices and can be internally or externally focused. Strategic practices are usually externally focused and define a firm’s environmental posture to key stakeholders. Results from the post hoc analysis are reported in Table 2.8. As can be seen, significant differences exist between types of EMPs, with respect to the power of temporality (Time + Year), firm, and industry to explain variation in adoption. Firm-unique choices and characteristics primarily explain the adoption of operational practices, temporality primarily explains the adoption of tactical practices, and industry primarily explains the adoption of strategic practices. These results are discussed in greater detail in the Discussion section.

Table 2.8 - Variance explained (by category and Type of EMP)[a, b]

	Combined	Operational	Tactical	Strategic
Time	31.4%	22.1%	39.8%	19.1%
Year	8.6%	6.3%	12.0%	7.8%
Firm	25.7%	42.8%	17.9%	25.1%
Industry	34.3%	28.8%	30.4%	48.0%

2.5 Discussion and Conclusion

In this study, we first identified unique sources of heterogeneity in EMP adoption across firms and examined their relative importance. We subsequently tested which firm characteristics and industry attributes contribute to explaining the heterogeneity. In the sections below, we highlight the contributions of our results and underscore their importance to theory, practicing managers, and regulatory agencies.

2.5.1 Discussion

Our study makes four important contributions. First, we empirically examine an implicit but untested observation that EMP adoption varies among firms, and this variation may have distinct, unique sources. To the best of our knowledge, this is the first study to broadly test the accepted conventional wisdom that heterogeneity in EMP adoption has distinct sources. The results from empirical analysis show that temporality, firm-unique choices and characteristics, and industry membership account for 40.0%, 25.7%, and 34.3% respectively of the aggregate variance in EMP adoption. In addition to determining relative importance of each source based on total variance, we evaluate relative importance using Brush and Bromiley's (1997) approach, who argue that using the square roots of the estimated variances provides a more accurate assessment. These results are quite similar (bottom panel of Table 2.5), with temporality, firm, and industry now accounting for 43.9%, 26.0%, and 30.1% of the variance in EMP adoption respectively.

We find that temporality has the largest explanatory power. This is not surprising given the ever-increasing pressure firms feel from regulators, NGOs, concerned citizens, and various other stakeholders to be environmental responsible. It is also not surprising that industry plays such a significant role, since industry regulation has been shown previously, and in the current study, to positively impact EMP adoption. Of potential surprise is the large explanatory power of firm-unique choices and characteristics. An important implication is that stakeholders who influence firms directly (such as customers, investors, firm employees, firm leaders, and local communities) are almost as important to EMP adoption decisions as regulators, who influence through industry regulation.

In a subsequent post hoc analysis, we evaluate how temporality, firm, and industry differentially impact the adoption of different *types* of EMPs. We find that operational decisions are primarily driven by firm-unique choices and characteristics, while strategic decisions are primarily driven by industry membership. This is an interesting result with important implications. It suggests that a firm's environmental strategy is heavily influenced by industry membership. This is not particularly surprising given the strong influence of institutional pressure on firm environmental behavior, as discussed previously. It also suggests that the operational choices a firm makes are primarily driven by the firm itself, as influenced by stakeholders who influence the firm directly and constrained/supported by firm characteristics. Given that operational changes likely have a more immediate impact on environmental performance, the results further highlight the central role firm-direct stakeholders should play in future efforts to increase EMP adoption and improve environmental performance.

Second, we demonstrate that not all firm characteristics and industry attributes matter to EMP adoption. Specifically, by simultaneously evaluating a broad set of firm and industry factors we determine which matter most to adoption and explain whether the effect is on EMP adoption over time (temporal effect), EMP adoption across firms or industries (cross-sectional effect), or both. As to firm characteristics, we show that firm size is positively associated EMP adoption over time. This suggests that as firm grow over time, they adopt more EMPs. We also show that firm size, profitability, labor availability, and prior experience adopting management practices (quality management systems and ISO 9000) are positively associated with EMP adoption. Surprisingly, we find that capital availability is not significantly associated with EMP adoption, implying that a firm's capital resources are *not* a prerequisite for EMP adoption. To ensure that our results are not driven by our operationalization of firm size, profitability, capital availability, and labor availability, we repeat our analysis using alternate measures for these firm characteristics, as described in Section 3.3.3. Results using these alternate measures (not included here) are essentially identical to the original results. The summary implications for managers adopting EMPs are that resource stability helps, available labor is essential, prior experience with ISO 9000 or a quality management system also helps, and much can be done without deep pockets.

As to industry attributes, we find that industry munificence is negatively associated with EMP adoption over time (Table 2.7, panel 1). This suggests that firms in low growth-potential industries adopt fewer EMPs over time. We also find that industry risk and competition are positively associated, and munificence, dynamism, and complexity are negatively associated, with EMP adoption (Table 2.7, panel 3). While the positive associations are consistent with our expectations, the negative associations were a surprise. As explained previously, munificence, dynamism, and complexity are three dimensions of environmental uncertainty, i.e. uncertainty in a firm's competitive landscape. The results suggest that as environmental uncertainty increases, firms adopt fewer EMPs, i.e. firms do not see the adoption of EMPs as necessary to grow the firm, address industry instability or handle industry complexity. Said differently, the implication is that EMPs are an afterthought when environmental uncertainty is high, but a higher priority when industry growth slows and when industries become more stable and/or less complex.

The overarching conclusion from the strategic factor analysis is that the relationships between strategic factors and EMP adoption are more nuanced and complicated than previously understood. One way to interpret the results is to understand how much flexibility management has in making the adoption decision. Industry attributes, for instance, act as external mandates (e.g., competition and risks firms face), leaving management little flexibility to decide what to adopt and how much to adopt. In contrast, management has considerable leeway in matching EMP adoption to firm characteristics, and perceived needs and requirements. Firm characteristics are more directly connected to management experiences (e.g., prior experience adopting a QMS) and can be more actively influenced by management decisions (e.g., making labor available), and thus are under management control to a larger extent. By differentiating between a mandate and a voluntary action, and their relative impact on EMP adoption, these results impart greater understanding to managers pursuing adoption, regulators designing rules, and researchers deciding which variables to include in future EMP adoption studies.

Third, our findings are significantly more generalizable than previous EMP studies because previous studies considered only a limited number of EMPs, used survey-based cross-sectional data, and evaluated firms in narrowly defined industries, such as furniture manufacturing (Klassen and Whybark, 1999), process industries (Bannerjee et al. 2003) or general manufacturing (Hofer et al. 2012). In contrast, we explore a broad set of EMPs, from many firms, industries and sectors, over a long period of time. This allows us to demonstrate adoption trends over time, and partition heterogeneity in EMP adoption into unique sources, across many different firm, industry, and business contexts. In addition, the set of EMPs (50 practices) we develop for this study more comprehensively covers the broad variety of activities firms undertake to manage their impact on the natural environmental. Finally, we identify a relatively new, comprehensive, and untapped secondary dataset which could prove to be very useful to future environmental management researchers.

2.5.2 Limitations and venues for future work

While we believe that the findings are interesting and impactful, there are several limitations and avenues for future research. First, while we include a broad set of strategic factors, based on an extensive literature review, it is nevertheless an incomplete set. Future researchers could examine additional factors that might be useful to various environmental stakeholders. Second, the influence of strategic factors on firm decisions regarding the adoption of EMPs may depend on the broader sector (2-digit SIC code) in which the firm competes. For example, manufacturing firms and service firms may respond differently to uncertainty in the competitive environment. Manufacturing firms impact the natural environment more significantly than service firms and thus the adoption of EMPs may play a more central role in managing competitive uncertainty for them because their stakeholders are watching them closer. However, limitations not-withstanding, we believe that our study makes a novel contribution to theory and practice by identifying unique sources of variation in EMP adoption and empirically validating our conceptual framework using rich panel data and an exhaustive econometric method.

Chapter 3 - The impact of a spill or pollution controversy on firm environmental activity

3.1 Introduction

Spill and pollution events such as the Bhopal Gas Tragedy, Exxon-Valdez Oil Spill, Chernobyl Disaster and Deepwater Horizon Oil Spill have lasting economic, social and environmental impacts. For example, the recent Deepwater Horizon Oil Spill (also known as the BP Oil Spill) discharged more than 4.5 million barrels of toxic oil in the Gulf of Mexico and affected over 8000 species of flora and fauna. It was also responsible for eleven deaths and cost BP $18.7 billion, the largest corporate settlement in U.S. history. Similar events of varying severity are reported regularly in the public media and generate negative publicity for firms. As profit seeking entities, firms are expected to address such public *controversies* by presenting an appropriate set of actions which will reduce the possibility of similar unanticipated events from occurring in the future. These actions include examining the firm's existing approach for managing its environment friendly management policies and practices (EMPs), and subsequently escalating or de-escalating adoption of EMPs in current and/or future years.

While escalating adoption in response to a spill and pollution (SP) controversy makes logical sense, it requires significant investment of scarce labor and financial resources. Alternately, de-escalating the year-over-year increases in adoption firms pursue in the absence of a controversy would secure time to analyze root cause and identify weaknesses with the current environmental strategy before adopting more EMPs. Given an uncertain relationship between increased adoption and reduced SP controversy risk, de-escalation could be a logical strategy. However, it is not clear how prevalent de-escalation might be with firm leaders or how long the effect may last. The net result of de-escalation is that firms adopts fewer EMPs than they would have adopted in the absence of a controversy and may continue adopting fewer EMPs in future years as well. De-escalation in adoption is a salient concern because the number of EMPs a firm adopts is directly associated with firm environmental performance (Anton et al. 2004, Klassen & Whybark 1999, Potoski & Prakash 2005, Toffel 2005, King & Lenox 2002).

In this paper, we study the relationship between a SP controversy and a firm's resulting decision to escalate or de-escalate adoption of EMPs. EMPs are the techniques, policies, and procedures a firm uses to monitor and control the impact of its operations on the natural environment (Montabon et al. 2007). Specifically, we examine three questions. First, does a SP controversy cause a firm to escalate or de-escalate adoption, and if so, how long does the impact persist? Second, how does the severity of the controversy, or number of controversies, impact this relationship? Finally, does firm size, firm sustainability performance or an industry's environmental risk profile moderate the relationship between SP controversy and EMP adoption? Using a unique panel data from 2003 to 2013 representing over 400 publicly-traded US manufacturing firms, and rigorous econometric methods, we show that in the absence of a SP controversy firms in all sectors steadily adopt more EMPs each year. However, in the year following a SP controversy they de-escalate adoption and this effect seems to persist for up to 3 years. It is important to note that de-escalation does *not* equate to a reduction in the number of EMPs adopted when compared to the prior year. Rather, it is a slowdown of annual increases in adoption and a reduction in the number of EMPs the firm *would have adopted* in the absence of a controversy. We also find that while experiencing more severe controversies or more controversies individually leads to greater de-escalation, they do not jointly affect the number of EMPs a firm adopts. Finally, we observe that firms with high environmental and social sustainability performance do not de-escalate adoption following a SP controversy, suggesting that such firms respond differently to SP controversies than most firms. These results suggest significant negative implications for short- and long-term environmental performance, especially because firms do not seem to recover from the slowdown in future years.

Results are robust to various econometric specifications, alternate measures of key variables, and panel choice, and help us make several contributions to existing literature. First, we shed light on a commonly held belief that firms escalate the adoption of EMPs in response to an environmental controversy, perhaps to strengthen their environmental management system or achieve legitimacy in their stakeholders' eyes. Instead, we find that firms (in aggregate) *de-escalate* adoption following a controversy and that this behavior persists over time, potentially resulting in a complete pause in adoption. Second, results indicate that factors other than stakeholder or institutional pressure, the primary theoretical lenses from which EMP adoption has been studied previously, influence firm decisions regarding EMP adoption (Delmas 2001, Delmas & Toffel 2008, Reuter et al. 2010, Sarkis et al. 2010, Foster et al. 2000, Hofer et al. 2012). The results also demonstrate that sustainability performance plays a critical role in how firms respond to SP controversies, with potential important implications for on-going firm environmental performance. Third, we develop a more robust definition of environmental management activity, and an expanded set of EMPs, which synthesizes a disparate literature on the subject of EMP adoption. Finally, we provide additional evidence for the viability and value of using publicly reported data to conduct environmental research. Such data is a valuable complement to the survey methods often used to conduct research in this area. It is not constrained by key informant or common method biases inherent in survey research (Roth 2007, Gattiker & Parente 2007), allows for replication studies, has a panel structure which supports the use of advanced econometric methods, and allows us to assess a significantly larger set of EMPs, industries, and firms, than prior studies.

3.2 Literature Review and Hypotheses Development

3.2.1 Environment management practices

Environment management practices encompass a variety of efforts designed to minimize the negative environmental impact of a firm's operations, or its supply chain, on the natural environment. Examples include changes to process, product, and technology, revised managerial policies, environmental training, voluntary participation in environmental standards development, and voluntary commitments to various emission reduction protocols, among others. EMPs constitute one dimension of firm level corporate social responsibility (Klassen & McLaughlin 1996). The topic of EMP adoption is informed by both the business strategy and operations management literatures. One of the recurring themes in the business strategy literature, the oldest and arguably most well-developed with respect to EMP adoption, is on exploring *why* firms adopt EMPs and identifying underlying causes of adoption. Institutional or stakeholder theories are frequently used to ground research questions which evaluate how pressure from various external and internal stakeholders, including customers, shareholders, competitors, regulatory bodies, and employees, among others, impact the decision to adopt (Ruenda-Manzanares et al. 2008, Banerjee et al. 2003, Madsen & Ulhoi 2001, Henriques & Sadorsky 1996). Broadly speaking, they find that while each of these stakeholders influence adoption decisions, their relative influence is context specific, such as dependence on specific characteristics of the firm or attributes of the industry in which the firm competes (Banerjee et al. 2003, Henriques & Sadorsky 1996).

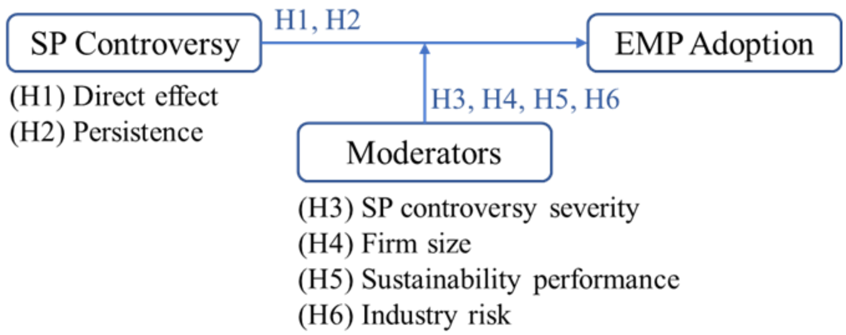
The operations management literature has also examined EMP adoption. This literature has more thoroughly evaluated the performance benefits emanating from adoption and found convincing evidence that the number of EMPs a firm adopts is positively associated with environmental (Anton et al. 2004, Klassen & Whybark 1999, Potoski & Prakash 2005, Toffel 2005, King & Lenox 2002), operational (Sroufe 2003) and financial performance (King & Lenox

2002). A separate stream focusing on causes of adoption has found that competitive rivalry (Hofer et al. 2012), training (Sarkis et al. 2010), and technological integration with suppliers and customers (Vachon & Klassen 2006) are associated with increased adoption.

Our review of the literature also shows that despite their distinct origins, these research streams have converged significantly in recent years. Although the motives for adoption may be similar across firms, the number of EMPs firms adopt varies greatly within and across industries, and performance outcomes depend on how adoption and firm performance are conceptualized and operationalized. For instance, EMPs have been conceptualized as environmental actions (Bannerjee 2001), environmental technologies (Klassen & Whybark 1999), and environmental management practices (Delmas & Toffel 2004, 2008, Montabon et al. 2007, Anton et al. 2004, Sroufe 2003), and the extent of firm involvement with environmental management has been measured with single item (e.g., ISO 14000) or multiple item scales ranging from a few practices to a maximum of 33 practices (Sroufe 2003, Montabon et al. 2007, Hofer et al. 2012). Similarly, firm performance has been conceptualized and operationalized along environmental (e.g., hazardous emissions), operational (e.g., quality, cost, lead-time, innovation), and financial (e.g., return on investment, sales growth, net profit) dimensions. Finally, while a handful of existing studies use secondary data (Montabon et al. 2007, Hofer et al. 2012), most use primary, cross-sectional data, and evaluate a reduced set of EMPs, firms, and industries (Sarkis et al. 2010, Sroufe 2003, Banerjee et al. 2003, Klassen 2001, Klassen & Whybark 1999, Aragon-Correa 1998).

We draw a number of conclusions from our extensive literature review which helps highlight our contributions to the existing literature. First, while there is an expansive literature examining how various stakeholders' impact a firm's decision to adopt EMPs, there is a paucity of research examining how unanticipated shocks, such as a SP controversy, impact that decision. Such controversies may dramatically impact firm decisions regarding adoption, especially given the logical, although unproven, link between increased adoption and reduced SP controversy risk. Further, previous studies have not examined whether SP controversies have a persistent impact on the number of EMPs a firm adopts over time. It is also not clear whether the relationship between a SP controversy and EMP adoption is contingent on firm and industry characteristics. In this research, we examine six hypotheses which represent both direct and moderating relationships between a SP controversy and the number of EMPs a firm adopts. Our conceptual research framework is presented in Figure 3.1.

Figure 3.1 - Research hypotheses



3.2.2 Spill and pollution controversies and EMP adoption

Previous research has shown that both positive and negative news reports can influence senior leaders' actions, both in terms of firm strategy and resource allocation (Xiong & Bharadwaj 2013). Consider senior leader actions following the negative publicity associated with the Exxon Valdez oil spill, where 11 million gallons of oil were spilled when the supertanker ran aground in Alaska in 1989. In addition to spending $4.3 billion in clean-up, fines, and settlement costs, Exxon Mobil spent significant resources in upgrading its operational management system, which included both preventive and reactive environmental management and safety programs.[12] Although most SP controversies are considerably smaller in scale and scope, unarguably they can significantly impact subsequent firm actions. Our research examines the role SP controversies play on a firm's approach to managing their impact on the natural environment.

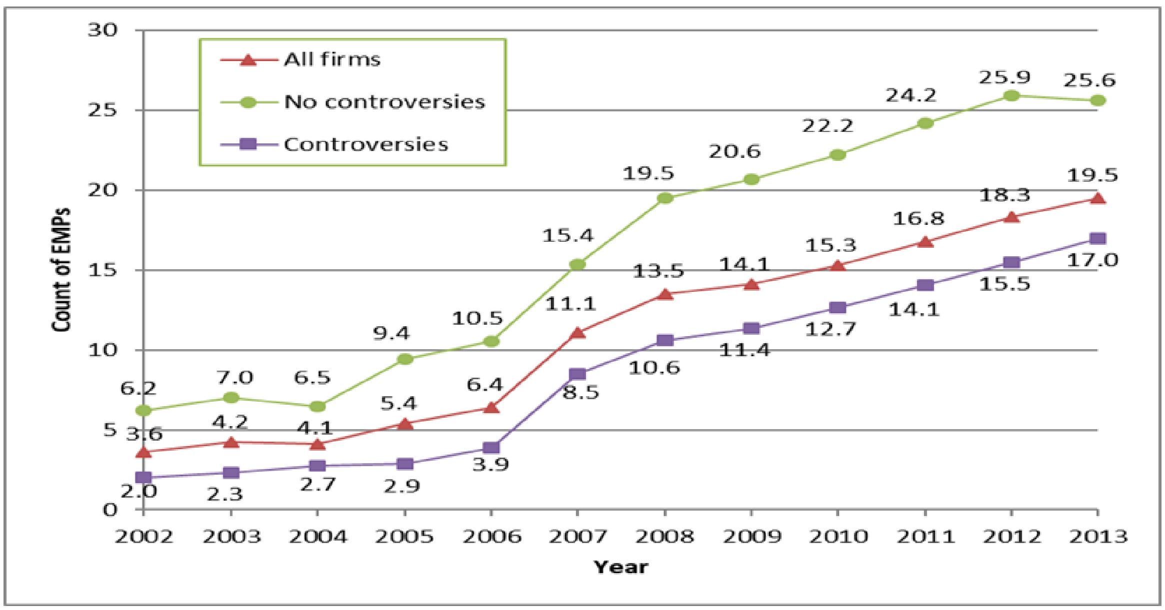
3.2.2.1 Firm response to a spill or pollution controversy

Firms adopt more EMPs each year because of a priori beliefs regarding the benefits of adoption (Figure 3.2). The adopted EMPs form the backbone of a firm's environmental management system, which in turn is responsible for firm environmental performance (Anton et al. 2004). A SP controversy would provide contradictory evidence as to the efficacy of existing adoption decisions and may even challenge the beliefs underlying those decisions. Using self-justification theory, subjective expected utility theory, and self-presentation theory, a cross-disciplinary literature evaluates whether decision-makers *escalate* or *de-escalate* commitments in such situations (Sleesman et al. 2012). They might escalate commitment if the decision-makers tasked with

[12] See http://corporate.exxonmobil.com/en/environment/emergency-preparedness/spill-prevention-and-response/valdez-oil-spill?parentId=ef7252d1-7929-4f5c-9fa2-05404bde2a0f

adoption decisions following a SP controversy are the same as those who made the original commitments. Escalation occurs because a felt responsibility may enhance the threat of decision failure (Staw 1976) or the need to protect one's self-identity (Brockner et al. 1986). Decision-makers may also escalate commitment if the decision faces outside evaluation. Outside evaluation may increase the desire to "save face" and manage impressions others have of them (Brockner et al. 1981). Finally, decision-makers may escalate commitment if they fundamentally believe in the given course of action, i.e. that the adoption of EMPs will improve environmental performance and reduce/eliminate future SP controversies (Schulz-Hardt et al. 2009). Alternately, decision-makers may de-escalate commitment if escalating commitment is perceived as a risky alternative. Risk increases loss probability (Knight 1921) and the salience of loss to decision-makers (Kahneman & Tversky 1979, March & Shapira 1987), which in turn reduces the utility of escalation and increases the utility of de-escalation (Schaubroeck & Davis 1994).

Figure 3.2 - Mean (Average) EMP adoption by year



While firms experiencing each decision scenario likely exist, an answer to what *most* firms will do following a SP controversy emerges after evaluating each scenario individually. While decision-makers responsible for adoption decisions following a SP controversy may be the same as those responsible for prior adoption decisions, this likely happens infrequently since EMP adoption takes place over many years and decision-making responsibilities typically change over time. Further, while some adoption decisions may face public scrutiny, such as those publicized in sustainability reports, firms publish these reports infrequently (sustainability reports are published 30% of the time in our sample) and information shared in them is not presented in a way which facilitates convenient year-over-year comparison. As such, pressure on decision-makers to do as much or more than the prior year may be minimal. Next, while some decision-makers may believe that escalated EMP adoption will reduce the risk of a future SP controversy, this relationship is unproven. While the adoption of EMPs may indirectly reduce the risk of a SP controversy by improving governance, process, and procedures associated with overall environmental performance, there is no specific EMP, or group of EMPs, specifically designed to reduce the risk of a SP controversy (see Appendix A). Finally, given that enhanced adoption increases labor and capital investments and is associated with uncertain future returns, it would likely be considered a risky decision path by most decision-makers. Taken together, we contend that an SP controversy will result in de-escalation of EMP adoption for most firms. However, given that firms generally pursue annual increases in adoption each year (Figure 3.2), this does not necessarily mean that a SP controversy will result in reduced adoption compared to the prior year, but rather reduced adoption compared to what a firm would have adopted in the absence of a controversy. The following hypothesis represents this logic:

> ***Hypothesis 1 (H1):*** *Spill or pollution controversies are negatively associated with the number of EMPs a firm adopts.*

3.2.2.2 The persistence of the firm response to a spill or pollution controversy

While we posit that firms will de-escalate EMP adoption following a SP controversy, it is unclear whether the impact will persist over time. The answer has important implications because the longer the impact persists, the greater the potential gap between the number of EMPs a firm actually adopts and the number of EMPs it would have adopted in the absence of an SP controversy. We believe that the impact of a SP controversy on firm behavior will persist for an extended period of time because it may take a long time to resolve the impact of the controversy on the natural environment and firm, identify root cause, and make the necessary process, policy, and/or strategy adjustments. The literature on organizational learning and change supports this conclusion. A review of the news articles connected with each SP controversy suggests they primarily result from, (1) process failures, (2) policy/strategy failures or (3) some combination of both. Thus, a SP controversy signals a breakdown of existing process control structures and its resolution requires re-evaluation of internal routines and procedures. Such breakdowns are not unusual, since even the best designed processes are subject to decay (increased instability over time) if not "renewed", such as through an audit (Anand et al. 2012). However, the significant changes required to resolve such breakdowns often emerge at a slow pace (Plowman et al. 2007, Wright et al. 2004). Since firms are likely to de-escalate adoption while they identify root cause, address fallout from the underlying SP event, and reassess their on-going environmental strategy (see H1), the pace of adoption will slow until these and other similar issues are addressed. Thus, we hypothesize:

> ***Hypothesis 2 (H2):*** *The impact of spill or pollution controversies on the number of EMPs adopted will persist over time.*

3.2.2.3 The severity of the controversy and firm response

In Hypothesis 1, we propose that most firms will respond to a SP controversy by de-escalating annual increases in adoption. We now propose that this response will be exacerbated by the severity of the SP controversy. On one end of the severity spectrum is negative publicity associated with localized spills or emissions violations that are contained to a specific plant or facility. They occur relatively frequently in some industries and less frequently in others and may involve a modest fine. On the other end of the spectrum is negative publicity associated with events that impact larger geographic areas and can involve very large fines and penalties (e.g. Exxon-Valdez oil spill, BP oil spill). Naturally, larger events require greater resources to resolve and manage, and thus garner a larger share of leadership attention. The attention-based view of the firm suggests that "firm behavior is the result of how firms channel and distribute the attention of their decision-makers" (Ocasio 1997). More severe controversies that garner greater leadership attention should be associated with more significant firm responses. In the current context, the more severe a SP controversy, the more pronounced the de-escalation.

> ***Hypothesis 3 (H3):*** *The severity of the controversy will amplify the relationship between spill or pollution controversies and the number of EMPs a firm adopts.*

3.2.2.4 The moderating role of firm size

While prior researchers have demonstrated a direct, positive relationship between firm size and the number of EMPs a firm adopts (Hofer et al. 2012, Delmas & Toffel 2008, Buysse & Verbeke 2003), it is unclear how firm size impacts similar decisions following a SP controversy. After reviewing the literature, we posit that decision differences will exist between small and large firms, with large firms less likely than small firms to de-escalate adoption following a SP controversy. Large firms have more slack resources, greater control over the environment, and broader skillsets (Hitt et al. 1990, Whetten 1987). The slack resources would allow large firms to address fallout from the environmental event without having to redirect scarce resources away from on-going environmental management activities. Large firms are also more bureaucratic and less flexible (Hitt et al. 1990, Whetten 1987); suggesting they may be more likely to continue with their embedded course of action, i.e. continue the current pace of adoption. Anecdotal evidence also suggests that large firms facing a SP controversy encounter greater attention from environmental stakeholders. As such, large firms may be inclined to continue the current pattern of annual increases in adoption in order to avoid scrutiny from these stakeholders. On the other hand, small organizations are said to be more innovative because they are more flexible, have a greater ability to adapt, and are more open to change (Damanpour 1996). As such, they may be more likely to revise their approach to environmental management following a SP controversy. In sum, because of increased resources and external stakeholder pressure, large firms will be less likely than small firms to de-escalate the adoption of EMPs following a SP controversy.

> ***Hypothesis 4 (H4):*** *Firm size positively moderates the relationship between SP controversies and the number of EMPs a firm adopts.*

3.2.2.5 The moderating role of sustainability commitment

Citing self-justification theory, researchers have shown that if decision-makers have experience or expertise in a given domain, they may escalate an existing course of action in response to negative feedback on that course of action as a way to justify the prior decision (Bragger et al. 2003, Garland et al. 1990). Similarly, decision-makers with high self-efficacy and confidence, such as that derived through experience, may escalate commitment when presented with negative feedback. Such individuals discount negative information, believing they can overcome any obstacles presented by the negative feedback (Judge et al. 1998). Finally, leveraging subjective expected utility theory, researchers have shown that decision-makers with a clear preference for a course of action will escalate that course of action when presented with negative feedback on that course of action. They escalate simply because they value, and thus prefer, the chosen course of action (Schulz-Hardt et al. 2009). In the current context, decision-makers in high sustainability firms will have gained experience and expertise in environmental and social sustainability. That experience and expertise should improve decision-maker self-confidence in making sustainability decisions (such as EMP adoption decisions); as well as create a preference for, and belief in, actions which support improved sustainability. As such, we contend that when high sustainability firms experience a SP controversy, as compared to lower sustainability firms, they will at least maintain their current pattern of adoption (annual increases) and potentially escalate adoption.

> ***Hypothesis 5 (H5):*** *Firm sustainability performance positively moderates the relationship between SP controversies and the number of EMPs adopted.*

3.2.2.6 The moderating role of industry environmental risk

Environmental risk involves temporary or permanent changes to the atmosphere, water, and land due to human activities, which can result in impacts that may be either reversible or irreversible. Firms in high risk industries experience a greater incidence of SP controversies. In fact, our data shows that such firms are 6 times more likely than low risk firms, and 2.5 times more likely than medium risk firms, to experience a SP controversy. Given the increased risk of negative environmental impact, firms in high risk industries also receive greater attention from regulators and other environmental stakeholders. Regulation, in particular, has been shown to influence organizational behavior, especially when it comes to adoption of environmental initiatives (Short & Toffel 2010). We posit that this increased experience with controversies, and increased scrutiny/oversight, causes firms in high risk industries to respond differentially to SP controversies than firms in less risky industries, with respect to escalating or de-escalating EMP adoption. For example, given their familiarity with environmental controversies, firms in high risk industries are more likely to have mature procedures for resolving the underlying SP event and for handling the negative publicity associated with the controversy. Thus, a SP controversy may have less impact on daily routines, and existing patterns of adoption, than it would for firms with less experience. Further, given their increased visibility, firms in high risk industries would be less inclined to take actions which could be perceived as counterproductive or harmful, such as de-escalating adoption. In sum, we expect firms in high risk industries to de-escalate adoption less than firms in lower risk industries, following a SP controversy.

> ***Hypothesis 6 (H6):*** *Industry environmental risk positively moderates the relationship between SP controversies and number of EMPs adopted.*

3.3 Data

3.3.1 Data sources and sample selection

We investigate EMP adoption in publicly-traded US manufacturing firms using data from two Thomson Reuter’s databases, ASSET4 and Worldscope, and First for Sustainability, an initiative of the International Finance Corporation. Annualized data on EMP adoption and SP controversies is obtained from ASSET4, a database used previously in related academic research (Ioannou & Serefeim 2012, Cheng et al. 2014, Eccles et al. 2014). Firm-specific information, including firm size and profitability, was obtained from Worldscope, a global financial and economic database used previously in academic research (Hawn & Ioannou 2016). Finally, a measure of industry environmental risk was developed using data from First for Sustainability. In our study, we focus on U.S. firms to eliminate potential heterogeneity in patterns of adoption across countries, as different countries may value environmental issues differently, include only publicly traded firms because financial information is federally mandated and readily available, and focus on traditional manufacturing industries because firms in these industries are a primary source of environmental pollution (Banerjee et al. 2003). Our unit of analysis is firm-year, our data spans from 2002 to 2013, and our sample includes 401 firms. Because new firms enter the panel each year, we have an unbalanced panel data structure.

3.3.2 Dependent variable

Number of EMPs adopted: Captures the depth and breadth of a firm's environmental management activity and is operationalized as a count of the EMPs firms report adopting each year. Firm involvement with environmental management has been operationalized in a variety of ways by previous researchers, including ISO 14001 adoption (Delmas & Toffel 2008, King et al. 2005), a single, multi-item construct (Ruenda-Manzanares et al. 2008, Christmann 2004), several multi-item constructs (Sarkis et al. 2010, Klassen 2001), a count of EMPs (Anton et al. 2004, Khanna & Anton 2002), and a count of EMPs, after adjusting for intensity of implementation (Hofer et al. 2012). We follow these latter two approaches, since they provide the most detailed assessment of a firm's involvement with environmental management. However, our measurement system offers advantages over prior approaches of value to environmental research. First, our set of 50 EMPs is the largest to-date and evaluates the full spectrum of environmental actions firms undertake to manage environmental performance. The largest prior set consisted of 33 activities (Hofer et al. 2012, Montabon et al. 2007, Sroufe et al. 2002). In fact, researchers have noted that existing environmental research has been conducted using a limited set of EMPs and highlighted the need to develop a more extensive and comprehensive set of EMPs (Montabon et al. 2007). Second, while we capture firm involvement with a specific practice as a binary variable, our summated scale allows us to effectively capture the depth and breadth a firm's involvement with environmental management. To explain, 41 of our 50 practices evaluate a firm's involvement in five broad approaches to improving environmental performance; implementing process improvement (8 EMPs), introducing KPI's (7 EMPs), implementing improvement initiatives (11 EMPs), implementing policies (11 EMPs), and working with suppliers/supply chain partners (4

EMPs). By summing the EMPs associated with each approach, we capture the *depth* of a firm's involvement with that approach. The remaining 9 EMPs refer to stand-alone actions a firm may take to improve environmental performance, such as "install an environmental management team", "adopt CEREZ principles", "participate in emissions trading", which are best measured using a binary scale. Thus, by summing the full set of 50 EMPs, we capture both the *depth* of a firm's involvement with the five broad approaches, as well as the *breadth* of a firm's involvement with environmental management.

To arrive at our final set of EMPs, we used information obtained from Thomson Reuters ASSET4 database. Thomson Reuters regularly reviews various public records, and reports adoption for a variety of EMPs using a binary scale (1=adopted, and 0=not adopted). To identify an appropriate set of EMPs for the current study, we were guided by three rules: to be included, a practice should, (1) be consistent with prior EMP literature conceptually, (2) be relevant to manufacturing firms, and (3) have no missing data. To meet the first criteria, we cross-checked the EMPs reported in the database against past literature. However, because published papers do not always report the measures they use, it was a challenging task. Even so, we found sufficient convergence across studies and it helped us narrow the list to 86 EMP practices. To meet the second criteria, we excluded practices that were not applicable to the firms and industries in our sample. Examples of such exclusions include whether the firm was a signatory of the UNEP Finance Initiative or the Equator Principles, both of which apply only to financial firms. This reduced the list of potential EMPs to 60. Finally, to meet criteria #3 we excluded any practice that had missing data in our panel. Our final set of 50 practices, including reported frequency of adoption, is presented in Appendix A.

3.3.3 Independent variables

Spill or pollution controversy: SP controversies represent "events published in the media linked to chemical, oil, and fuel spills, as well as controversies related to the overall impacts of the company on the environment". They include "any of the company activities which may directly or indirectly pollute the environment or the surrounding area, be it air, water or soil, or cause pollution". To create this variable, Thomson Reuters collects news articles from various public and private sources including company issued press releases, company websites, and media publications, for each firm. The analysts then go through each news article and remove all duplicate news reports. The resulting information is reported in ASSET4.

Spill or pollution controversy severity: To assess severity, we develop three unique measures using information provided in the news article attached to each controversy. They include cost, scope, and settlement, each of which captures a unique aspect of severity. The measures were developed in a systematic and rigorous manner. First, the lead author developed a conceptual definition of each measure. *Cost* (severity_cost) was defined as the "total cost of fines and cleanup". *Scope* (severity_scope) was defined as the geographic impact of the controversy on the environment, and was measured as 1 = local impact (e.g. town/city), 2 = regional impact (e.g. state), and 3 = broad impact (e.g. multiple states). We used no controversy = 0 as the reference category. *Settlement* (severity_settlement) was defined as the "stage" in the resolution process to which the controversy had progressed when made public. It was measured as 1 = spill event occurred, 2 = lawsuit filed, 3 = fine assessed, 4 = settlement reached. Again, no controversy = 0 was used as the reference category. If more than one controversy occurred during the year, *cost* refers to the sum of the costs across all controversies, while *"scope"* and *"settlement"* evaluate the controversy with the most advanced geographic spread and stage, respectively. Second, each author read each article in its entirety and coded them independently following the schema described above. Third, the results from the coding by the three authors were compared to identify points of similarity and difference. In cases where two or more authors agreed in their coding, there was no further discussion. In the few rare cases where results differed, all three authors reread each of the news articles to resolve the disagreement. In total, 532 news reports were coded for each measure of severity.

3.3.4 Moderating variables

Firm size: We split our sample into two evenly sized groups based on mean annual sales across a firm's entire panel. In this way, we categorized an entire firm, as opposed to each firm-year observation, as small or large. We chose this approach because we believe that firm behavior and choices regarding the natural environment will be relatively homogenous across years of the panel. Sales data used to develop this variable was sourced from Worldscope.

Sustainability performance: We classify firms as high performance in the years they participate on a sustainability index, such as the Dow Jones Sustainability Index (DJSI), and low otherwise. Inclusion on a sustainability index indicates that a firm's environmental, social, and economic performance is among the very best. For example, the DJSI World Index includes only the top

10% of eligible firms. Data used to measure participation on a sustainability index was obtained from ASSET4.

Environmental risk: Measures the risk an industry poses to the natural environment, and as proxy, the level of attention an industry receives from environmental stakeholders, such as regulators and NGO's. To measure environmental risk, we obtained environmental and social risk assessments compiled by First for Sustainability (FFS), an initiative of the International Finance Corporation, to monitor how the environmental and social risks are being managed by financial institutions receiving their investments.[13] FFS classifies 29 sectors (collections of industries) into high, medium, and low risk to the natural environment. The study authors mapped these assessments to industries, as defined by the Industry Classification Benchmark (ICB), a globally recognized standard similar to Standard Industrial Classification (SIC) system used in the US. The study authors separately and independently substantiated that the environmental risk was correctly reflected in the sector to industry to firm mapping. Because our study focuses on industries which pose greater environmental risk, the study sample includes only medium and high-risk industries.

3.3.5 Control variables

Consistent with prior related research, we include a number of variables to control for their unobserved effects on the number of EMPs a firm adopts.

Other environmental controversies: Although SP controversies account for about 80 percent of all environmental controversies tracked by Thomson Reuters, firms may also experience other environmental controversies not related to spills and pollution events (e.g., biodiversity or product impact). Firms may adopt EMPs in response to these "*other environmental controversies*" and may systematically differ from each other in the number of these other environmental controversies they experience. Thus, we include a count of all other environmental controversies experienced by a firm in period *t-1* (the same period as SP controversies) to control for this potential source of heterogeneity, using data sourced from ASSET4.

Firm Size: Larger firms have more capital, labor and technology resources, and firm size has been shown previously to impact the number of EMPs a firm adopts (Hofer et al. 2012, Delmas &

[13] See www.firstforsustainability.org for the assessments.

Toffel 2008, Christmann 2004). To control for such resource heterogeneity, we use the natural log of corporate sales (Hofer et al. 2012) using data sourced from Worldscope.

Others: As additional controls, we include year dummies, sustainability performance, and industry environmental risk. We also include industry dummies for certain robustness checks.

In examining our data, we find that all firms in our panel adopt more EMPs each year, from an average of 3.6 EMPs per firm in 2002 to 19.5 EMPs in 2013 (the center line in Figure 3.2). These increases are observed whether a firm experienced a SP controversy (bottom line in Figure 3.2) or not (top line in Figure 3.2). This is not surprising since environmental management has garnered increased attention over the last few decades, culminating with the recent Paris Agreement on climate change.[14]

Descriptive statistics and a correlation matrix for all variables in the analyses are provided in Table 3.1. We find that firm size and sustainability performance are positively correlated, and environmental risk is negatively correlated, with the number of EMPs a firm adopts. This suggests that large firms and firms highly committed to sustainability adopt a higher number of EMPs, while firms in industries which present higher risk to the natural environment adopt fewer practices. We also observe that firm size is positively correlated with our various measures of controversy, suggesting that large firms have more SP controversies, as well as other environmental controversies. Finally, we notice that two measures of controversy severity, scope (severity_scope) and settlement (severity_settlement), as well as our binary (controversy) and count (cumulative controversies) measures of controversy, are highly correlated with each other, suggesting overlap in their ability to uniquely characterize a SP controversy.

[14] http://unfccc.int/paris_agreement/items/9485.php

Table 3.1 - Descriptive statistics and correlations

		Mean	Min	Max	StdDev	1	2	3	4	5	6	7	8	9	10	11	12
1	EMP adoption$_t$	12.70	0	46	12.29	1.00											
2	Other environmental controversies$_{t-1}$	0.04	0	5	0.27	0.14*	1.00										
3	Firm size$_t$	15.00	3.69	19.89	1.63	0.51*	0.18*	1.00									
4	Sustainability commitment$_t$	0.14	0	1	0.35	0.58*	0.10*	0.37*	1.00								
5	Environmental risk$_t$	1.68	1	2	0.47	-0.03	0.02	-0.11*	-0.07*	1.00							
6	Controversy$_{t-1}$	0.09	0	1	0.28	0.24*	0.24*	0.31*	0.13*	0.08*	1.00						
7	Cum controversies$_{t-1}$	0.15	0	15	0.65	0.23*	0.38*	0.31*	0.12*	0.08*	0.73*	1.00					
8	Cum controversies$_{t-2}$	0.14	0	9	0.60	0.21*	0.34*	0.32*	0.09*	0.08*	0.41*	0.61*	1.00				
9	Cum controversies$_{t-3}$	0.14	0	9	0.58	0.20*	0.30*	0.31*	0.06*	0.08*	0.33*	0.54*	0.63*	1.00			
10	Cum controversies$_{t-4}$	0.13	0	9	0.54	0.17*	0.33*	0.32*	0.05*	0.08*	0.32*	0.54*	0.52*	0.60*	1.00		
11	Severity_cost$_{t-1}$	$15.9M	0	$27B	$516M	0.04*	0.08*	0.07*	0.05*	0.02	0.10*	0.15*	0.06*	0.06*	0.15*	1.00	
12	Severity_scope$_{t-1}$	0.16	0	3	0.57	0.26*	0.28*	0.32*	0.16*	0.07*	0.93*	0.80*	0.48*	0.39*	0.38*	0.15*	1.00
13	Severity_settlement$_{t-1}$	0.24	0	4	0.85	0.23*	0.24*	0.28*	0.14*	0.07*	0.91*	0.74*	0.43*	0.38*	0.37*	0.12*	0.86*

*$p<0.05$

3.4 Empirical approach and results

3.4.1 Empirical approach

We investigate the relationships in our study using fixed-effect (FE) negative binomial regression (using Stata's xtnbreg command). We have repeated observations for firms over an eleven-year period, and the data structure is an unbalanced panel with a negative binomial distribution. Given the nature of our data, we considered a number of alternate methods, including ordinary least squares (OLS), Poisson, General Estimating Equation (GEE), and random-effects (RE) negative binomial regression. *OLS regression* is not appropriate because it requires assumptions about the variance that are not likely to be met (Gardner et al. 1995). *Poisson regression* is a single parameter model which assumes the mean and variance of the dependent variable are equal. In our data, the ratio of variance to mean is 14.5, suggesting significant over-dispersion. The negative binomial distribution specifically adds a second parameter to account for this over-dispersion and hence is likely a better match for our data structure (Gardner et al. 1995). *GEE regression* is another method appropriate to analyze over-dispersed count data when autocorrelation and unobserved cross-sectional heterogeneity may be present (Greene 2012, Di Gregorio & Shane 2003, Sine et al. 2003, Liang & Zeger 1986). While an Arellano-Bond test does not find evidence of autocorrelation, we are unable to test for unobserved cross-sectional heterogeneity and thus evaluate the GEE model as a robustness check. Finally, we perform a Hausman test to evaluate whether fixed- or random-effect negative binomial regression is more appropriate. We find that the FE model best fits the data (χ^2=104.96, pValue<0.0001) and thus proceed using a FE negative binomial regression model to investigate our research hypotheses.

3.4.2 Results

Results from FE negative binomial regression analysis are presented in Table 3.2. Variance Inflation Factors (VIFs) in all models are at or below 3.4, ameliorating multicollinearity concerns (Kutner et al. 2005).

Table 3.2 - Negative binomial regression analysis

	1	2	3	4	5	6	7
Other environmental	-0.02	-0.02	0.01	0.01	0.02	0.02	0.02
controversies$_{t-1}$	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Firm size$_{t}$	0.12***	0.13***	0.14***	0.14***	0.14***	0.14***	0.13***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Sustainability	-0.09*	-0.09*	-0.10*	-0.10*	-0.07+	-0.05	0.00
commitment$_{t}$	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Environmental risk$_{t}$	0.26*	0.25*	0.27*	0.28*	0.17	0.17	0.15
	(0.11)	(0.11)	(0.11)	(0.11)	(0.13)	(0.16)	(0.27)
Controversy$_{t-1}$		-0.08*		0.02			
		(0.03)		(0.04)			
Cumulative			-0.07***	-0.07***	-0.04**	-0.04*	-0.03*
controversies$_{t-1}$			(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
Cumulative					-0.05**	-0.03*	-0.02+
controversies$_{t-2}$					(0.02)	(0.01)	(0.01)
Cumulative						-0.03*	-0.01
controversies$_{t-3}$						(0.02)	(0.01)
Cumulative							-0.02
controversies$_{t-4}$							(0.02)
Constant	-2.08***	-2.20***	-2.39***	-2.38***	-1.55**	-1.03+	0.35
	(0.52)	(0.53)	(0.52)	(0.52)	(0.56)	(0.62)	(0.71)
Observations	3015	3004	3004	3004	2577	2159	1765
chi2	3375.31	3361.10	3394.59	3395.37	2730.23	2104.80	1598.54

OIM standard errors in parentheses, + p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Year fixed-effects included in all models, but not shown

We first include only control variables (column 1) and find that firm size and environmental risk are positively associated, while sustainability performance is negatively associated, with the number of EMPs a firm adopts. Although not shown, each year dummy is significant and steadily increasing in magnitude over time, as observed visually in Figure 3.2. To assess the impact of SP controversy on EMP adoption, we first evaluate controversy as a binary variable in period *t-1*, i.e. the firm experienced one or more controversies in the period or zero controversies (column 2). We find that prior year controversy is negatively associated with the number of EMPs adopted in the current year (β= -0.08). Since firms increase adoption each year in the absence of a controversy (Figure 3.2), this does not equate to reduction in EMP adoption from the prior year, but rather de-escalation in annual increases and a reduction in the number of EMPs the firm *would have adopted* in the absence of a controversy. We discuss this further in the Discussion section. We next evaluate the impact of our count measure of controversy (*cumulative controversies)* at t-1 on the number of EMPs adopted in the current year (column 3). We observe a negative and statistically significant relationship (β= -0.07), indicating that as firms incur more controversies they de-escalate adoption more than if they had experienced only a single controversy. Finally, we evaluate the binary and count measures of controversy together in one model (column 4). We find that the direction, magnitude, and significance of the beta connected to the count measure is relatively unchanged from our prior analysis, while the beta connected to the binary measure has lost significance. Variance Inflation Factors for this model are all below 2.9. The results suggest that the count measure of controversy better captures firm behavior following a SP controversy, with respect to the number of EMPs a firm adopts. As such, we use this measure of controversy in all future analyses. In total, the results provide strong support for H1.

We next assess the persistence of the impact discussed above. To do this, we progressively add controversies with longer lags (i.e. prior years) to the model (columns 5-7). In general, we see that as older controversies (t-2, t-3, and t-4) are added to the model, the beta associated with controversies in period t-1 gets progressively smaller. This suggests that these older controversies are contributing to the result we observe for cumulative controversies at t-1 (column 3). Further, we see the controversies at t-2 and t-3 remain at least moderately significant in all models. The net conclusion is that the impact of a controversy on EMP adoption persists for up to 3 years, providing support for H2.

To assess whether the severity of SP controversy *amplifies* the de-escalation in adoption we observe following a SP controversy, we test for moderation by creating an interaction term between each measure of SP controversy severity, *cost* (severity_cost), *scope* (severity_scope), and *settlement* (severity_settlement), and our count measure of controversy (cumulative controversies). The results are provided in Table 3.3. We first introduce our reference model (column 1), then each measure of severity as a main effect (columns 2-4), and finally the interaction terms (columns 5-7). The results show that each main effect is negative and highly significant, suggesting that as controversies become more severe, de-escalation becomes more pronounced. We next observe that each interaction term is insignificant, suggesting that severity does not amplify the relationship between SP controversy and the number of EMPs a firm adopts. However, because of high correlation between severity_scope, severity_settlement, and cumulative controversies, models 8 and 9 have issues with multicollinearity (VIFs > 10, Kutner et al. 2005). We discuss this result in the Discussion section, where we present an alternate approach to assess moderation for these two measures of severity.

Table 3.3 - The impact of the "severity" of the spill or pollution controversy

	1	2	3	4	7	8	9
Other environmental controversies$_{t-1}$	0.01	-0.02	-0.01	-0.01	0.01	0.01	0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Firm size$_t$	0.14***	0.13***	0.14***	0.14***	0.14***	0.15***	0.14***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Sustainability commitment$_t$	-0.10*	-0.09*	-0.09*	-0.09*	-0.10*	-0.10*	-0.10*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Environmental risk$_t$	0.27*	0.26*	0.25*	0.26*	0.28*	0.28*	0.27*
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Cumulative controversies$_{t-1}$	-0.07***				-0.03	0.04	0.00
	(0.02)				(0.03)	(0.06)	(0.04)
Severity_cost$_{t-1}$		-0.01***			-0.00		
		(0.00)			(0.00)		
Severity_scope$_{t-1}$			-0.06***			-0.02	
			(0.02)			(0.02)	
Severity_settlement$_{t-1}$				-0.04***			-0.01
				(0.01)			(0.01)
Cum. controversies$_{t-1}$ * Severity_cost$_{t-1}$					-0.00		
					(0.00)		
Cum. controversies$_{t-1}$ * Severity_scope$_{t-1}$						-0.04+	
						(0.02)	
Cum. controversies$_{t-1}$ * Severity_settlement$_{t-1}$							-0.02
							(0.01)
Constant	-2.39***	-2.21***	-2.34***	-2.24***	-2.36***	-2.45***	-2.33***
	(0.52)	(0.52)	(0.53)	(0.52)	(0.52)	(0.53)	(0.53)
Observations	3004	3003	3003	3003	3003	3003	3003
chi2	3394.59	3380.71	3378.31	3378.88	3402.38	3407.23	3401.09

OIM standard errors in parentheses, + $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
Year fixed-effects included, but not shown

In our final analyses, we investigate the moderating effect of firm size, sustainability performance, and industry environmental risk. Because we theorized that the relationship between SP controversy and the number of EMPs adopted differs by categories of firm size, sustainability performance, and industry environmental risk, we use subgroup analysis (Venkatraman 1989). To do so, we create high and low sub-samples of the moderating variable, and conduct regression analysis within each sub-sample (Table 3.4). We then compare the resulting SP controversy beta coefficients across sub-samples using a t-test (Bruning & Kintz 1987, pp. 226-228).

Table 3.4 - Moderators – Firm size, sustainability index, and environmental risk

Dependent Variable	EMPs adopted$_t$						
Hypothesis Evaluated		Hypothesis 4		Hypothesis 5		Hypothesis 6	
		Firm Size		Sust. Performance		Env. Risk	
Model	1	2	3	4	5	6	7
	All	Small	Large	Low	High	Medium	High
Other environmental controversies$_{t-1}$	0.01	0.05	0.01	0.02	-0.02	0.05	-0.02
	(0.03)	(0.17)	(0.03)	(0.04)	(0.03)	(0.06)	(0.03)
Firm size$_t$	0.14***			0.13***	0.03	-0.00	0.26***
	(0.03)			(0.04)	(0.05)	(0.05)	(0.04)
Sustainability commitment$_t$	-0.10*	-0.02	-0.04			-0.06	-0.14**
	(0.04)	(0.12)	(0.04)			(0.06)	(0.05)
Environmental risk$_t$	0.27*	-0.37	0.38**	0.34*	-0.38		
	(0.11)	(0.34)	(0.13)	(0.14)	(403.01)		
Cumulative controversies$_{t-1}$	-0.07***	0.01	-0.05**	-0.09***	-0.00	-0.13**	-0.06***
	(0.02)	(0.06)	(0.02)	(0.02)	(0.01)	(0.05)	(0.01)
Constant	-2.39***	0.15	-0.02	-2.57***	17.39	-0.19	-3.41***
	(0.52)	(0.68)	(0.23)	(0.64)	(585.80)	(0.76)	(0.59)
Observations	3004	1167	1838	2506	478	1015	1989
chi2	3394.59	1086.23	2417.97	2900.02	545.31	1124.68	2416.86

OIM standard errors in parentheses, + p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Year fixed-effects included, but not shown

Relative to firm size, the beta coefficient for SP controversy connected to small firms is not statistically significant (column 2), while the beta connected to large firms is negative and significant (column 3). However, the t-test comparing the betas indicates they are not statistically different (t=0.96, pValue=0.34, df=1312) and H4 is *not* supported. We next observe that the beta associated with low sustainability performance is negative and highly significant (column 4), while the beta connected to high sustainability performance is not significant (columns 5). The t-test results provide strong *support* for H5, implying that high sustainability firms do *not* de-escalate adoption following a SP controversy, while low sustainability firms de-escalate (t=3.43, pValue<0.001, df=2751). Finally, relative to industry environmental risk, we observe that firms in both high and medium environmental risk industries de-escalate adoption following a SP controversy (columns 6 and 7), but firms from high environmental risk industries de-escalate adoption less than firms from medium environmental risk industries, a result consistent with H6. However, the t-test shows that the difference is not statistically significant (t=1.57, pValue=0.12, df=1224) and thus H6 is *not* supported.

3.4.3 Robustness checks

We conduct several robustness checks to ensure that the results relative to H1 are not biased by our choice of research method, measure of SP controversy, panel choice or sample (selection bias). Results are presented in Table 3.5. For comparison purposes, column 1 includes the results from our initial analysis.

Table 3.5 - Robustness checks – Method, measurement, panel, and sample

	xtnbreg, fe	xtgee	ordinal	2002-2012	PSM
Model	1	2	3	4	5
Other environmental controversies$_{t-1}$	0.01	-0.03	0.00	0.02	-0.01
	(0.03)	(0.04)	(0.03)	(0.04)	(0.02)
Firm size$_t$	0.14***	0.45***	0.14***	0.18***	0.14***
	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)
Sustainability commitment$_t$	-0.10*	0.04	-0.09*	-0.04	-0.03
	(0.04)	(0.11)	(0.04)	(0.05)	(0.03)
Environmental risk$_t$	0.27*	0.43**	0.27*	0.18	-0.50**
	(0.11)	(0.13)	(0.11)	(0.13)	(0.18)
Industry fixed-effects		X			
Firm fixed-effects					X
Cumulative controversies$_{t-1}$	-0.07***	-0.08**	-0.07***	-0.08***	-0.03**
	(0.02)	(0.03)	(0.02)	(0.02)	(0.01)
Constant	-2.39***	-6.30***	-2.38***	-3.02***	0.56
	(0.52)	(0.66)	(0.53)	(0.68)	(0.63)
Observations	3004	3117	3004	1605	1979
chi2	3394.59	1602.27	3388.08	2382.24	4067.39

OIM standard errors in parentheses, + $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
Year fixed-effects included for each model, but not shown
[a]PSM = Propensity Score Matching

While we initially evaluated H1 using fixed-effect (FE) negative binomial regression, such a method can only address within-firm variation (Dobrev et al. 2001). As noted previously, GEE models have also been used to evaluate negative binomially distributed count data, such as ours (Shah et al. 2016, Hofer et al. 2012). They are attractive because they can accommodate serial correlation, allow for robust standard errors, and address potential unobserved cross-sectional heterogeneity concerns, a source of latent heterogeneity (Greene 2012, Wowak et al. 2015).

Although our data did not exhibit autocorrelation, unobserved cross-sectional heterogeneity may be present and affect our results. Therefore, we re-evaluate our results using a GEE model with a negative binomial distribution, a log linear-link function, and an exchangeable working correlation structure (it corrects for potential serial correlation by allowing shared correlation between observations within a group). As shown in column 2, the substantive results with the GEE model are almost identical to those from our original model (column 1).

While the majority of firms that experience a controversy, experience only a single controversy in a given year, a small number of firms experience multiple controversies (one firm experienced as many as 15). To reduce the potential impact of outliers on our results, we repeat our analysis using an ordinal measure of SP controversy. For this measure; 0=no controversies, 1=1 controversy, 2=2 controversies, 3=3 controversies, 4=4 or 5 controversies, and 5=6 or more controversies in a single year. The results from this analysis (column 3) are again almost identical to the original results, providing support for the conclusion that our results are not driven by outliers. Note that we also evaluated a binary measure of SP controversy when investigating H1 (Table 3.2, column 1) and also found almost identical results.

The results from the main model included all firms for which data was available. However, the behavior of new firms entering the panel each year regarding EMP adoption may systematically differ from firms that entered the panel earlier. To ensure that our results are not driven by our panel choice, we evaluate a reduced set of 149 firms for which data were available for each year in the panel. This resulted in 1605 firm-year observations (as compared to 401 firms and 3004 firm-year observations in our main model). The results from this smaller sample are virtually identical to our original model (column 4).

As a final robustness check, we investigate the possibility that self-selection bias may be contributing to our results. Self-selection bias would occur if firms are predisposed to experience a controversy (or not) based on characteristics of the industry in which they compete or attributes of the firm itself, such as small or large size. Such characteristics and attributes could then be over/under represented in the treated (experienced a controversy) and untreated samples, and impact our conclusions. A common method used to address such bias is Propensity Score Matching. In this method, firms are first evaluated with regard to their propensity to experience a SP controversy. Firms that 'did' and 'did not' experience a controversy, but had similar propensities to experience a controversy, are then matched against each other in the analysis. The results from this analysis are shown in column 5. Matching variables include; other environmental controversies, firm size, sustainability performance, environmental risk, and year. The propensity score was estimated using Logit. While we observe a smaller beta connected to SP controversy, the sign is still negative and highly significant, suggesting that self-selection bias is not responsible for the behavioral results we observe.

3.5 Discussion and Conclusion

3.5.1 Theoretical implications

Interest in protecting the natural environment has never been more acute globally. Yet, more and more companies are experiencing SP controversies each year. As the first study to evaluate how firms respond to such controversies, with respect to the number of EMPs they adopt, it is especially timely and relevant since management actions following a controversy can significantly affect a firm's on-going impact on the natural environment. We find that firms which experience a SP controversy respond, on average, by de-escalating on-going adoption of EMPs, i.e. they adopt fewer EMPs in future years than they would have adopted had the controversy(ies) not occurred and may even pause adoption altogether should they experience multiple controversies or more severe controversies. The slowdown seems to last for up to three years. Further, a comparison of scatterplots for firms who have experienced a controversy and those who haven't (Figure 3.2) suggests that firms don't recover from the slowdown in future years. We also observe that high sustainability firms do *not* de-escalate adoption following a SP controversy, suggesting that these firms take a different approach to resolve the issues underlying the SP event and related controversy. We discuss the theoretical and practical implications of these results next. Summarized results from all analyses are presented in Table 3.6.

Table 3.6 - Summary of results

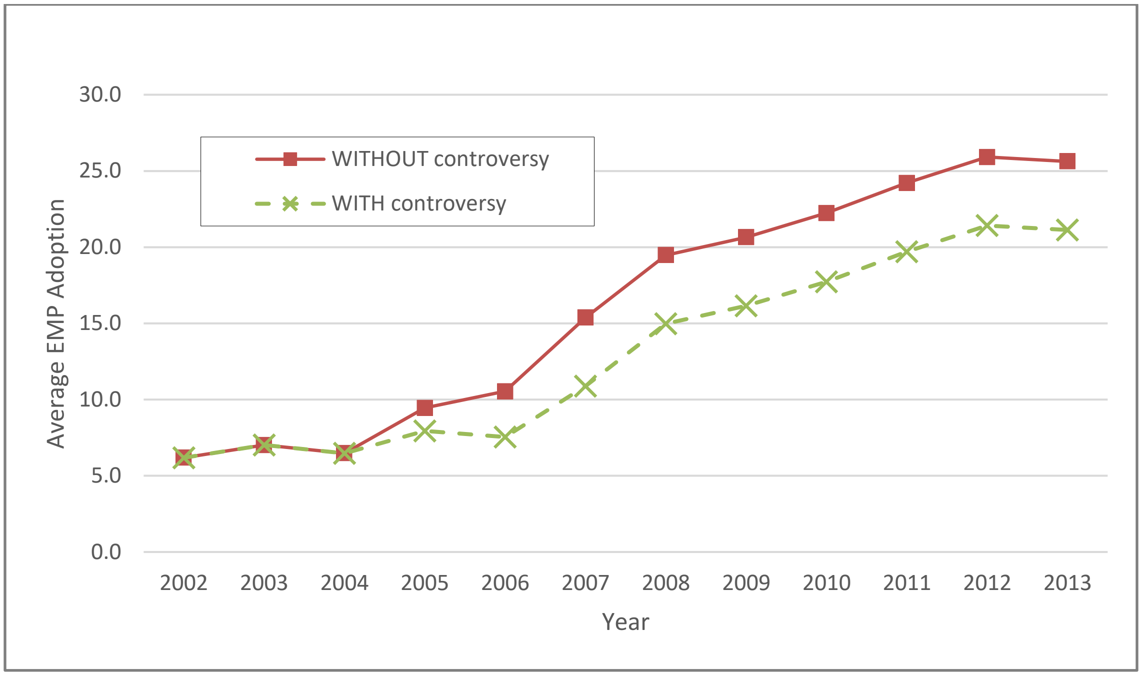
Hypothesis	Empirical Test	Hypothesized Sign	Empirical Analysis
H1 (SP --> EMP)	SP_{t-1} --> EMP_t	Negative	−, Significant
H2 (time)		Negative	
	SP_{t-1} --> EMP_t		−, Significant
	SP_{t-2} --> EMP_t		−, Significant
	SP_{t-3} --> EMP_t		−, significant
	SP_{t-4} --> EMP_t		Not significant
H3 (severity as moderation)	Moderated regression analysis	Positive	Not significant
Moderation			
H4 (firm size)	Subgroup analysis	Positive	Not significant
H5 (sustainability performance)	Subgroup analysis	Positive	+, Significant
H6 (environmental risk)	Subgroup analysis	Positive	Not significant

3.5.1.1 Spills and Pollution Controversy and the Adoption of EMPs

In H1, we hypothesize that most firms de-escalate EMP adoption following a SP controversy. Our results support this conclusion. We first show that firms, *on average,* respond to SP controversy (experiencing 1 or more unique controversies) by de-escalating on-going adoption of EMPs (Table 3.2, column 2, β= -0.08). The observed beta translates into an approximate 8% de-escalation in the number of EMPs the firm would have adopted in the absence of a controversy (due to the negative binomial model, the effect is interpreted multiplicatively after exponentiation, i.e. 1 - $\exp^{\beta}$ = 1 - $\exp^{-0.08}$ = 1 - 0.92 = 0.08 or an 8% reduction; Gardner et al. 1995). This equates to a de-escalation of approximately 1.5 EMPs (2013 average EMP adoption from Table 3.1 = 19.5; 8%*19.5=1.5). We also observe that each unique controversy can cause a 6% de-escalation (Table 3.2, column 3) or about 1.2 EMPs. Considering that firms which do *not* experience a controversy *increase* EMP adoption annually by about 2.1 EMPs (the slope of the line when regressing EMP adoption on year – see Table 3.1), the summary conclusion is that should a firm incur a single controversy, they will slow adoption, and should they incur multiple controversies in the same year they will de-escalate adoption further, possibly resulting in a complete pause in new adoption. These conclusions are robust to the method used for analysis, approach to measuring SP controversy, panel choice, and self-selection bias (see Table 3.5). Because EMPs include a broad set of practices which vary greatly in intent, scope, resource requirements, and intended performance (Sroufe et al. 2003), we conduct a final evaluation where we consider whether the de-escalation effect is universal or focused on a certain type of EMP. Prior researchers have captured EMP differences by using various categorization schemes, such as whether the EMP has an operational, tactical or strategic focus (Montabon et al. 2007), whether it addresses pollution prevention, pollution control, or product stewardship (Hart 1995, Bansal 2005) or whether it is directed externally or internally (Matten & Moon 2008). We evaluate each of these categorization schemes, but do not find evidence of selective de-escalation (results available upon request). Thus, we conclude that the de-escalation effect we observe affects all types of EMPs similarly.

While the magnitude of the de-escalation is significant, we also observe that the slowdown seems to persist for up to three years (H2) and more controversies, or more severe controversies, cause greater de-escalation. However, while the severity of the controversy has a direct impact on the number of EMPs a firm adopts, it does *not* seem to *amplify* the impact of simply incurring one or more controversies (H3). This conclusion was established definitively for our cost attribute of severity, but results evaluating the two other measures of severity, scope and settlement, were inconclusive. To further evaluate the moderating impact of these additional severity attributes, we calculate the average number of EMPs adopted in the year following a controversy and partition the results by degree of severity (results available upon request). While increased severity appears to cause increased de-escalation, t-tests do not support that differences exist between subgroups. Thus, severity of the controversy (by any measure) does not seem to amplify the effect of a SP controversy on the number of EMPs a firm adopts. One final observation is that firms do not appear to recover from the slowdown, i.e. they never return to the level of adoption they would have realized had they not experienced a controversy. As evidence, simple scatterplots of EMP adoption over time show that firms which *have* experienced a controversy adopt 30% - 66% as many EMPs as firms which *have not* experienced a SP controversy (Figure 3.2). As such, the ultimate impact of the controversy on the number of EMPs a firm adopts, and the potential associated impact on environmental performance, may persist for the life of the firm. We summarize our findings visually in Figure 3.3.

Figure 3.3 - Conceptual schema to represent results



3.5.1.2 Role of firm size, sustainability commitment, and industry environmental risk

In our final analyses (H4 – H6), we evaluate boundary conditions on the behavioral response we observe in H1. To this end, we evaluate the moderating role of two firm attributes, size and sustainability performance, and one industry attribute, environmental risk. We find that the decision to de-escalate adoption does not depend on the size of the firm or whether a firm competes in an industry which presents greater risk to the natural environment. However, we do observe that high sustainability firms do *not* de-escalate adoption following a SP controversy. We argue that such firms do not de-escalate adoption in order to demonstrate commitment to their a priori beliefs regarding the value of EMPs. This finding is important because it shows that firms pursue alternate strategies following a SP controversy.

Taken together, the results paint a rather nuanced picture of how American manufacturing firms prioritize their environmental responsibilities. On one hand, we observe a direct and positive relationship between time and the numbers of EMPs firms adopt, and that this relationship is more pronounced for firms which have never experienced a SP controversy (Figure 3.2). This is very encouraging, as the number of EMPs a firm adopts is positively associated with improved environmental performance (Anton et al. 2004, Klassen & Whybark 1999, Potoski & Prakash 2005, Toffel 2005, King & Lenox 2002). On the other hand, while the observed de-escalation in adoption following a SP controversy may be a conscious and sensible attempt to secure time to assess root cause, learn, and develop more impactful environmental strategies, it may also suggest tepid senior leader commitment toward their environmental responsibility. If commitment is tepid, improved future environmental performance will require stronger environmental stakeholder oversight, as opposed to self-generated improvements initiated by responsible firm leaders.

These results are interesting because previous research has not demonstrated the lingering effects of a SP controversy on managerial decision making. Although anecdotal evidence suggests long term effects, they have not been studied previously. They are particularly interesting because "small, incremental managerial decisions and actions are not easy to observe and evaluate objectively" (Klassen and McLaughlin 1996, p. 1204). Our results show that a firm which has faced a controversy not only adjusts its decisions accordingly, but also exhibits institutional memory where those decisions are concerned.

3.5.2 Conclusion

This study makes several contributions to the academic literature. First, we identify and examine how spill and pollution controvers(ies) impact the number of EMPs a firm adopts. To our knowledge, this is the first study to examine this relationship. We empirically show that, contrary to received wisdom, firms de-escalate the adoption of EMPs following a SP controversy. Previous researchers have asserted that the patterns of managerial action required for developing and maintaining a preventative management system, like that needed to manage environmental performance, only evolve over long periods of time. Perhaps previous studies were not able to identify these short-term relationships because the measures used to assess EMP adoption were high level proxies, such as an environmental award (Klassen & McLaughlin 1996) or ISO certification (Gavronski et al. 2008, 2013, Delmas & Toffel 2008, King et al. 2005, King & Lenox 2001), which only result from longer term patterns of decision making. Perhaps aggregated and lagging proxies of EMP adoption do not provide an accurate estimate of which practices firms actually adopt to manage their environmental performance, nor do they allow researchers to track changes in the pattern of actions over time. By measuring the actual practices firms use to manage their environmental impact, we are able to immediately and accurately evaluate how firms respond to various stimuli, such as a SP controversy.

Second, we evaluate an important driver of EMP adoption which is unrelated to stakeholder or institutional pressure. While numerous studies examine the adoption of EMPs, a majority of them, especially at the organizational level, focus on *why* firms adopt, often using stakeholder and institutional theory to hypothesize that firms adopt in response to pressure from various stakeholders, both external and internal to the firm (Delmas 2001, Delmas & Toffel 2008, Reuter et al. 2010, Sarkis et al. 2010, Foster et al. 2000, Hofer et al. 2012). We have shown that the number of EMPs a firm adopts is a function of a SP controversy, which is disconnected from stakeholder or institutional theories. Moreover, we assess this relationship over time, lending credibility to the cause-effect nature of the relationship.

Third, we broaden the definitional domain of EMP's (as first put forth by Sroufe 2003). A more robust and nuanced measurement of EMP adoption allows for deeper understanding of the relationships connected to adoption. Finally, we provide additional evidence for the viability and value of using publicly reported environmental data to conduct environmental research. Such data is a valuable complement to the survey methods often used to conduct research in this area. While surveys provide specificity, they can be subject to key informant and common method bias (Roth 2007; Gattiker & Parente 2007) and are difficult to replicate. Our data is gathered from multiple, secondary sources, and thus not subject to key informant or common method bias. Also, since it is publicly available, replication studies are possible. Further, its panel structure allows us to use advanced econometric methods, which provide greater control for rival explanations and the ability to investigate lagged relationships. In addition to the afore-mentioned advantages, our dataset also allows us to assess a significantly larger set of EMPs, a greater number of industries, and a larger set of firms, than prior studies. This improves the generalizability of, and confidence in, our conclusions.

3.5.3 Limitations and venues for future research

While we believe that our results provide compelling evidence in support of our conclusions, several potential limitations deserve mention. While we clearly demonstrate that an average firm de-escalates the adoption of EMPs in response to a SP controversy, and that they do not seem to recover from the slowdown in future years, we did not examine the impact of such a slowdown on future environmental performance. While we do not expect environmental performance to *drop* as a result of a SP controversy, we do expect *de-escalation* of future environmental performance improvements commensurate with the de-escalation in EMP adoption. Such an investigation might be a productive avenue for future research.

A second limitation is that our decision to focus on U.S. manufacturing firms may limit the generalizability of our findings. Future researchers could examine whether our results hold true in other countries, specifically in Europe. European countries have been noted to be more proactive than the United States with regard to environmental management. Increased proactivity might suggest more pressure on European firms to resolve their deficiencies and thus impact their response to a SP controversy. Ultimately, understanding how firms respond to a SP controversy is important to environmental stakeholders around the globe.

A third limitation is using annual measures for EMP adoption and SP controversies. More granular time slices (such as quarterly or monthly) could help identify the detailed sequence of actions and reactions which define the broader firm response to a SP controversy. Our data can be thought of as aggregations of these short-term actions and reactions. Given that preventive management systems often evolve over time, our aggregated view might in fact provide a better understanding of overall management intent than a micro analysis of each individual step involved in that transition.

A final limitation is that some firms may over-report EMP adoption due to socially desirable responding (Paulhus 2002). Because we are interested in changes in the number of EMPs a firm adopts from one year to the next in response to a SP controversy, reporting biases become inconsequential if the firm follows a consistent approach from year-to-year. However, should a firm switch from over-reporting to under-reporting, this could contribute to the de-escalation we observe. However, the desire to over-report may be tempered because, (1) many firms have their environmental reports audited, while others leverage external reporting standards to ensure consistency in their reporting, and (2) informal auditing by customers, non-government organizations (NGO's) or government entities can result is severe consequences for firms which provide misleading information (Delmas & Cuerel Burbano 2011).

Other opportunities to extend our results also exist. For example, it would be interesting to assess whether other types of negative firm events, such as a product recall, which may occur more frequently, generate firm responses similar to what we observe in the current research. It is possible, even likely, that other organizational "shocks" could also trigger a slowdown in the adoption of EMPs. It would also be interesting to evaluate whether adopting more EMPs reduces the occurrence (risk) of future SP controversies. An answer would be valuable to practitioners and researchers alike.

Chapter 4 - Do environmental controversies affect the product recall decision?

4.1 Introduction

On June 4th, 2012, U.S. national news outlets reported that Costco will pay $3.6M in fines for "improper storage, handling and disposal of hazardous waste and pharmaceutical waste products in many stores".[15] Similar public announcements of firm environmental failures occur regularly in many firms across industries, such as Ford, Pfizer, Honeywell, Wal-Mart, and Coca-Cola. Undoubtedly, environmental protection has gained greater visibility in the public psyche in recent years[16] and every spill or pollution event attracts substantive media attention. Negative media attention from such events, which we term environmental controversies, has the potential to harm firms in a number of different ways. They are socially toxic for firms and can hamper on-going firm development (Garbarino 1995). They attract unwanted negative attention from government regulators, including fines and penalties (Sarkis et al. 2010, Delmas & Toffel 2004). They result in reduced stock prices and market valuations (ex. Klassen & McLaughlin 1996, Flammer 2013, Endrikat 2016). Finally, environmental controversies may generate concerns about a firm's operational capability resulting in reputational losses that have uncertain long-term consequences (Flammer 2013, Karpoff et al. 2005, Jones & Rubin 2001).

While market value and reputational losses are relatively obvious consequences of an environmental controversy, there may be less discernible, but equally important impacts on seemingly-unrelated firm decisions. We contend that the firm management would be in a difficult decision-making quandary if, after experiencing an environmental controversy, it is faced with another distinct and unrelated failure, albeit one that has similar negative attributes as an environmental controversy. Examples of such events include decisions to close or move facilities, outsource production, announce financial challenges or layoffs, or announce product quality issues, such as a product recall. It is not clear whether firm managers would choose to accelerate the release of the subsequent negative news or hold onto it and delay its release as a way to minimize additional fallout. In this paper, we focus on one such scenario and examine if the time to disclose a second piece of negative information changes if the firm has already had a negative experience, such as an environmental controversy.

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[15] https://www.bizjournals.com/sacramento/news/2012/06/04/costco-fined-waste-products-settlement.html
[16] http://www.people-press.org/2018/01/25/economic-issues-decline-among-publics-policy-priorities/

Whether firms couple or decouple two pieces of negative news depends on management's belief about the impact of the second announcement. Firms will accelerate the release of the second announcement and couple it with the first announcement if releasing them in relative time proximity is likely to reduce the negative impact of the second announcement (Gennotte & Trueman 1996). Alternately, firms will delay the second announcement if decoupling them reduces the impact of the subsequent failure on the firm (Kothari et al. 2009, Grenadier et al. 2014, Chattopadhyay et al. 2001). Such coupling and decoupling have been studied previously in the context of accounting and financial information disclosures (Segal & Segal 2016, Dye 2010, Tse & Tucker 2010, Kothari et al. 2009). However, a vast majority of the papers examine two pieces of closely related information in a limited set of industries. We depart from this literature in two significant ways: first, we evaluate two unrelated negative news announcements, and second, we study them in a diverse set of industries. Specifically, we study whether an environmental controversy has an impact on a subsequent, seemingly-unrelated operational decision, a product recall, in the five largest recalling industries. Our primary research question is: *Do prior environmental controversies impact the timing of a future product recall announcement?* We believe that finding evidence in support of such a relationship will demonstrate that public environmental failures impact firms in surprising and important ways.

We focus on a product recall as the subsequent failure because, like environmental controversies, it is socially toxic, raises questions about a firm's operational capability, and attracts scrutiny from regulators. The timing of the recall announcement is of specific interest because it has significant potential repercussions for both firms and consumers. For firms, recalls are associated with reduced market share (Van Heerde, et al. 2007, Rhee & Haunschild 2006), lower share price (Chen, et al. 2009, Davidson & Worrell 1992, Jarrell & Peltzman 1985) and tainted public image (Archer & Wesolowsky 1996). For consumers, a delayed recall frequently results in inconvenience, personal suffering, and depending on the product, potential safety implications (Ball et al. 2017).

In addition to assessing the nature of the relationship between an environmental controversy and the timing of a product recall, we evaluate whether the relationship is contingent upon the elapsed time between the controversy and the recall decision. Logically, the relative attention a negative or positive event is likely to garner from firm management should reduce with time. Thus, how management responds to the second event is likely to depend on the duration of time between the two events because management actions are directly related to the amount of attention the event captures (Ocasio 1997). We use this logic to ground our second research question: *Does the elapsed time between an environmental controversy and a subsequent product recall moderate the relationship between the controversy and the timing of a future product recall announcement?*

We investigate our research questions using an accelerated failure time model (Box-Steffensmeier and Jones, 2004) and a 11-year panel data (2002 – 2013) from five industries which frequently recall products. These are auto, pharma, medical device, food, and consumer products. Our data spans 120 firms, and consists of 154 environmental controversies and 4355 product recalls. The results show that firms which have experienced environmental controversies delay the product recall announcement by almost 50%; that is, they take significantly longer to announce a voluntary product recall. We also find that the longer it has been since the most recent controversy, the weaker the relationship between an environmental controversy and the timing of a recall. Our results are consistent across each recall industry, and robust to reverse causality, self-selection bias and the set of firms included in the sample.

This study makes three important contributions. First, by showing that environmental performance affects a firm's managerial decision making related to product quality, we contribute to the environmental management literature. While prior researchers have demonstrated that environmental failures that become public controversies result in market share and reputational losses, we demonstrate that they also impact important operational decisions, such as the timing of a product recall. By linking environment and operations management research, we bridge an important gap in the existing literature.

Second, we contribute to the literature on product recalls. Because we only include recalls that are voluntarily initiated by firms, our results show that firms that have experienced an environmental controversy delay the product recall announcement when firm management has discretion in the timing of a recall. Our results imply that when managers have some discretion, they are likely to postpone recalling products when they are experiencing negative environmental pressure. This has important implications for product recall research because many studies treat recalls as an objective measure of product quality, and future researchers may need to reconsider this assumption. In environmental controversies, we also find a common leading indicator of recall timing across five industries which capture the vast majority of recalls in the U.S., making it the broadest recall study to-date.

Finally, we contribute to literature on information disclosures related to how firms manage multiple instances of bad news. Existing literature in this area is limited. A handful of studies that exist focus on bad news announcements that are related and investigates them in a narrow context limited to one or two industries. In contrast, we examine events, which are seemingly unrelated. Moreover, our finding that managers tend to delay the release of a second instance of bad news is more generalizable because we include multiple industries.

4.2 Literature Review and Hypotheses

In this section, we first develop a theoretical relationship between an environmental controversy and a product recall. In this relationship, the timing of the environmental controversy is assumed to be exogenous to the firm and precedes the decision to recall a product. The timing of the product recall is a discretionary decision made by firm managers, given knowledge that the firm has already experienced an environmental controversy. We subsequently develop formal research hypotheses which detail the form of the relationship, i.e. they answer the questions of whether firm managers prefer to couple or decouple operational bad news and whether the influence of an environmental controversy on firm decision making diminishes over time.

4.2.1 Environmental controversies and product recalls

On the surface, a voluntary product recall announcement would seem unrelated to whether a firm had recently experienced an environmental controversy. Instead, recall decisions would seem to reflect a rational balance between the costs/risks to conduct or forgo a recall. However, while seemingly-unrelated, environmental controversies and product recalls share several unique characteristics important to firm managers. We describe them briefly below.

Environmental controversies and product recalls are both socially toxic because they constrain on-going firm development (Garbarino 1995). Social toxicity is observed in how stakeholders critical to firm development express their disappointment. For instance, customers withhold sales leading to market share losses, investors sell shares leading to share price reduction, and the general public reduces their opinion of the firm resulting in reputational losses. Without the support of customers, investors, and the public (a source of future customers), firms are unable to grow and develop. Both failures also generate questions about a firm's operational capability. As such, environmental controversies and product recalls may raise doubts in a firm customers' and investors' minds about management's ability to effectively manage their operations and prevent future failures. These doubts may explain, in part, the market share and stock price declines associated with environmental controversies and product recalls. Finally, environmental controversies and product recalls are uniquely related because both are closely monitored by federal and state regulatory agencies, and attract undesirable attention, oftentimes in the form of fines and penalties.

In sum, we conclude that environmental controversies and product recalls are related because they share unique characteristics important to firm managers, i.e. they (i) are socially toxic, (ii) demonstrate weakness in firm operational capabilities, and (iii) attract attention from government regulators. These characteristics may be, at least in part, responsible for the share price, market share, and reputational losses associated with these events. As such, we suspect that firm managers manipulate the timing of a product recall following an environmental controversy to minimize additional fallout from another negative event which shares these characteristics. This link between an environmental controversy and a product recall motivates the following hypotheses which explore whether firm managers decelerate or accelerate recall announcements following an environmental controversy, and whether the influence of an environmental controversy on firm decision-making diminishes over time.

4.2.2 Firm disclosures of bad news

Our study is informed by the rich literature related to information disclosure in the context of finance and accounting information at publicly traded firms. A majority of this literature is focused on the content (i.e. what information is released), timing (i.e. when the information is released), and motives (i.e. why the information is released) behind information disclosure. In the context of timing, most researchers have looked at releasing a single piece of bad news. This set of papers shows that firms may couple their release with bad news announcements from other firms. This phenomenon is known as *blending in with the crowd* (Grenadier et al. 2014) or *herding* (Tse & Tucker 2010) and rests on the idea that if multiple firms disclose similar pieces of bad news, the root cause of poor performance may not be firm specific. Instead, it could be attributed to factors outside firm control, such as a weak economy.

An emerging sub-stream of information disclosure research specifically examines how *one* firm releases two pieces of bad news. We focus on this set of papers in our review as they are most directly related to our research, with one nuance. While most of the previous studies examine two pieces of news that are somewhat related in nature, our study focuses on two pieces of news which would appear to be unrelated: an exogenous event in the form of environmental controversy and an operational decision in the form of product recall, where the firm has some leeway in terms of announcement timing. Notwithstanding this nuance, we believe that the lessons generally apply and briefly review this literature in developing our hypotheses below.

A foundational concept in this literature is that because managers disclose information, not firms, timing and content of disclosure is a function of the value managers derive from such decisions (Beyer et al. 2010). Value is appropriated due to the information asymmetry that exists between managers and investors, and agency theory suggests that the interests of managers and investors are not always aligned. When facing the decision to publicly disclose bad news, firm management may either accelerate or delay the second piece of news. In making this decision, firm management is guided by a desire to reduce the *informativeness* of the news, thereby reducing the negative impact of the bad news on the firm. Informativeness can be described as the ability of the news to convey information regarding the capability or quality of the firm's management team (Grenadier et al. 2014). If coupling the current bad news with prior bad news reduces informativeness (Gennotte & Trueman 1996), managers may accelerate the announcement of bad news. Alternately, if informativeness can be reduced by releasing the news when key stakeholders are less attentive (Segal & Segal 2016), they may delay the release of bad news.

Relative to accelerating bad news, Gennotte & Trueman (1996) show that when a firm has two pieces of corporate financial information to disclose, managers maximize firm value by coupling bad news and decoupling good news. The authors reason that management couples bad news because markets can only process so much information in one release. Separating good news allows firms to maximize the value of each announcement, while bundling bad news reduces the negative impact of each announcement made independently. However, in our context, many product recalls may not occur in close-enough time proximity to an environmental controversy to realize value from coupling. Thus, while accelerating the product recall announcement following an environmental controversy is a theoretical possibility, it is practically unrealistic in our context. As such, we focus on the alternate scenario of delaying the product recall announcement.

Here, researchers have shown that firms, on average, delay the release of bad news (Kothari et al. 2009) and that bad news is especially withheld if it speaks poorly to the abilities of firm managers (Grenadier et al. 2014). Researchers also find that a manager's desire to withhold bad news seems to be a function of career concerns, as subsequent corporate events may allow managers to bury the bad news (Kothari et al 2009, Nagar et al. 2003, Nagar 1999). A variety of scandals demonstrate that manager's personal incentives motivate them to withhold important information from stakeholders.[17] In sum, it seems clear that firm managers would typically prefer to delay the announcement of a product recall, as delay is perceived to be less risky to the firm and their careers. However, in our research context, the firm will have already experienced at least one environmental controversy prior to the recall decision. We know from the threat-rigidity hypothesis that risk aversion increases when managers are confronted with an organizational threat (Chattopadhyay et al. 2001). Thus, given an existing threat in the form of an environmental controversy, and an understanding that firm managers perceive delay as the least risky decision, firm managers will choose to delay the recall. Hypothesis 1 represents this logic:

> ***Hypothesis 1 (H1):*** *An environmental controversy is associated with a delayed time to recall.*

4.2.3 Environmental controversies and the passage of time

Beyond assessing the nature of the relationship between an environmental controversy and the timing of a product recall, we are interested in understanding whether the influence of an environmental controversy on the timing of a product recall diminishes as the controversy ages, i.e. the elapsed time between the controversy and the recall decision increases. We know that what decision-makers do is a function of what captures their attention (Ocasio 1997). Those issues which capture more managerial attention will have a greater impact on managerial decision-making. In our case, environmental controversies which are fresh in a manager's mind should have greater influence on decision making, as expressed through the timing of the recall announcement. As controversies age, we would expect their impact on managerial behavior to diminish. In sum, we contend that the passage of time since the most recent environmental controversy serves to dampen the effect of a controversy on the timing of a recall. If Hypothesis 1 is true, the passage of time since the most recent controversy will result in less delay.

> ***Hypothesis 2 (H2):*** *The relationship between environmental controversy and the time to recall is moderated by the time since the environmental controversy, such that the longer the time since the controversy, the weaker the relationship between controversy and the time to recall*

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[17] See Charton (2006), Kothari et al. (2006), Bergstresser & Phillipon (2006), Burns & Kedia (2006), and Cheng & Warfield (2005) for examples.

4.3 Data and Variables

4.3.1 Sample and data sources

In this study, we investigate the relationship between an environmental controversy and a product recall. Environmental controversy data was obtained from Thomson Reuter's ASSET4 database. ASSET4 has been used in prior studies to examine causes and effects of environmental and socially responsible firm practices (Iannou and Serefeim, 2012; Cheng et al., 2014; Eccles et al. 2014). We incorporate a novel measure from ASSET4 that to our knowledge has not been used in prior studies, that of "spill and pollution controversies". For convenience, we subsequently refer to this measure as "environmental controversies". This measure captures "events published in the media linked to chemical, oil, and fuel spills, as well as controversies related to the overall impacts of the company on the environment". They can include "any of the company activities which may directly or indirectly pollute the environment or the surrounding area, be it air, water or soil, or cause pollution".[18] In assembling this data, Thomson Reuters collects news from various public and private sources, including company issued press releases, company websites, and media publications. Duplicate news reports are removed before making the data available to researchers. Note that ASSET4 does not report the date when the event occurred, but instead focuses on the date when the firm experienced negative media attention due to an environmental event. Environmental controversy data was gathered for years 2002 through 2013.

Product recall data are obtained through multiple Freedom of Information Act (FOIA) requests and from U.S. regulatory websites. Auto recalls were collected from the National Highway Traffic and Safety Administration (NHTSA). Medical device, pharmaceutical and food recalls were collected from the Food and Drug Administration (FDA), and consumer product recall were collected from the Consumer Product Safety Commission (CPSC).[19] While all the agencies provide the firm name and the recall date, they vary greatly in the other details they provide. For instance, the FDA includes a recall classification which categorizes recalls into different classes based on severity, but the NHTSA and CPSC do not provide severity measures. Also, while the NHTSA accurately reports the number of vehicles associated with an automotive recall, the FDA and CPSC provide inconsistent measures of recall volume, such as five lots, six cartons, or 50 units. Because of this inconsistency, we cannot reliably include recall severity or

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[18] http://www.trcri.com/index.php?page=asset4

[19] FDA also oversees cosmetic, biologic and veterinary industries. Because of their similarity, we include cosmetic and biologic recalls in the pharmaceutical category, and veterinary in the food category.

recall volume in this study. Additionally, while the NHTSA mandates approximately 20% of the automotive recalls, the FDA and CPSC do not normally force firms to recall their products. We therefore only use voluntary recalls in our study because we explore how firms behaviorally respond to an environmental controversy. Financial data used to compute control variables was obtained from COMPUSTAT.

In determining the sample frame for our study, our goal was to be as inclusive and comprehensive as possible. Thus, we collected data from all industries, and their constituent firms, which had the potential to experience both an environmental controversy and a product recall. However, while most firms that could experience a recall could also experience an environmental controversy, the opposite may not always be true. For example, on April 24, 2012 the Department of Justice announced that Freeport-McMoRan mining company had agreed to pay $6.8M in penalties for environmental damages caused by their copper mining operations in Arizona.[20] However, since they don't make products, they do not experience product recalls. To develop a list of industries from our data which could experience both a recall and an environmental controversy, we began with 4-digit SIC codes for all industries in our recall data. We chose 4-digit SIC codes to define industries to be consistent with prior research and to be restrictive in our identification of comparable firms which could experience both an environmental controversy and a product recall (King et al. 2005, King & Lenox 2001). The industries from our recall data were then matched to industries included within our environmental controversy data (ASSET4), i.e. industries which could have experienced environmental controversy. In this way, we limited our environmental controversy data to only those industries in which recalls were possible. In other words, if a 4-digit SIC code from ASSET4 was not present in the recalling data, we did not include it in the study.

After establishing an industry set, we then determined which firms to include from each chosen industry. Because the recalling data included all firms within an industry, while the controversy data did not, we began by considering only firms tracked in our controversy data. We then removed any firms that did not experience either a controversy or a recall, as these firms are non-informative. Firms were matched across datasets using stock ticker symbols. The final sample included 120 publicly traded firms from 59 industries, 154 environmental controversies, and 4355 product recalls representing five recalling industries that account for a vast majority of

[20] https://www.justice.gov/opa/pr/freeport-mcmoran-corp-and-freeport-mcmoran-morenci-inc-will-pay-68-million-damages-injuries

recalls. These are automotive, medical device, pharmaceutical, food, and consumer products.[21] Because ASSET4 data is not available prior to 2002, the timeframe of our sample is from 2002 to 2013. Table 4.1 provides a summary of our sample, including a count of firms, controversies and recalls across the panel time period, broken out by recall industry.

Table 4.1 - Controversy and recall counts

	Auto	Pharma	Med device	Food	Consumer	Total
# of controversies	14	13	31	28	68	154
# of recalls	1055	1230	1756	138	176	4355
No. of observations	1069	1243	1787	166	244	4509
# of firms with controversies and no recalls	1	1	9	6	6	23
# of firms with recalls and no controversies	4	10	26	13	18	71
# of firms with controversies & recalls	4	4	3	4	11	26
No. of firms	9	15	38	23	35	120

Note: The number of controversies and recalls sum to the total number of observations.

4.3.2 Variables

4.3.2.1 Dependent variable

The dependent variable in our research is the time to product recall. It is measured as the number of days from a firm's entry in the dataset to the product recall announcement. The time starts when the firm is first tracked by ASSET4, as this is the limiting dataset (the recall database evaluates a broader timeframe), and ends when the firm files the necessary paperwork with the appropriate federal oversight agency. Filing the paperwork and announcing the recall, which informs customer, investors, and the public of the intent to recall, generally occur concurrently or within very close time proximity. We also evaluate only unique recalls. Duplicates are manually removed from the dataset by reading each recall description and using identifiers provided by the federal oversight agencies to identify duplicate and closely related recalls.

4.3.2.2 Independent variables

The independent variable in our study is an environmental controversy. We measure environmental controversies in two ways. We first capture a rolling count of the number of

[21] The 5 recalling industries include the following 4-digit SIC codes: 2000, 2020, 2030, 2033, 2040, 2050, 2060, 2080, 2086, 2090, 2300, 2400, 2510, 2590, 2621, 2670, 2750, 2810, 2820, 2834, 2836, 2840, 2842, 2844, 2851, 2860, 2870, 3021, 3089, 3490, 3510, 3523, 3540, 3561, 3570, 3576, 3577, 3578, 3600, 3630, 3663, 3670, 3674, 3679, 3711, 3714, 3728, 3790, 3812, 3822, 3823, 3826, 3841, 3842, 3844, 3845, 3861, 3942, 3944

controversies a firm experiences across its panel (*Cumulative Controversies*). We begin counting when the firm is first tracked by ASSET4 and zeros are included for observations prior to the first recorded controversy. The count is then incremented by one when the next controversy occurs and so on. We subsequently create a dichotomous measure of controversy (*Dichotomous Controversy*) to evaluate whether the absence/presence (0/1) of environmental controversy prior to the recall impacts the time to recall. To create this measure, all Cumulative Controversy counts above 0 were converted to ones. While the cumulative measure was used throughout the analyses, including robustness checks and post hoc, evaluating a dichotomous measure allowed us to evaluate whether firms respond to a count of controversies differently than to the simple presence of prior environmental controversy.

4.3.2.3 Moderation variables

Days Since Controversy. To examine Hypothesis 2, we measure for each firm the time in days from the most recent controversy. The counter is reset when the same firm experiences a subsequent controversy. Observations prior to the first controversy are recorded as zeros. Because this variable is positively skewed, we use the natural log of the raw count in the analysis.

4.3.2.4 Control variables

Year. Regulatory policies may become more or less strict over time, potentially affecting firm decisions regarding recalls (Ball et al. 2017). To control for this, we use an indicator variable for each year of the panel and treat 2002 as the reference category.

Sales revenue. Larger firms likely experience more recalls than smaller firms (Ball et al. 2017). This experience may in turn impact recall behavior. To control for this possibility, we include sales revenue as a proxy for firm size (Hofer et al. 2012, Delmas & Toffel 2008). Because this variable is positively skewed, we use the natural log of annual sales revenue in all analyses (Hofer et al. 2012, Delmas & Toffel 2008).

Return on Sales. Firm profitability has been shown to impact firm behavior (Zhang et al. 2008). In the current context, firms that are more efficient and profitable may behave differently when considering product recall decisions. To ensure these potential behavioral differences do not influence our results, we control for profitability, using return on sales as a proxy (Hofer et al. 2012). Return on sales is calculated as the net income of a firm for a given year divided by sales.

R&D intensity. R&D intensity has been shown in past literature to affect the number of recalls (Thirumalai and Sinha 2011). We thus control for R&D intensity at the firm level, measuring it as the ratio of R&D expenses to firm sales. Because this variable is positively skewed, we use the natural log of this measure in all analyses.

Firms. There are 120 firms in our sample, all of which may have different propensities to recall that do not change over time. To control for heterogeneity across firms, we include 119 indicator variables in all analyses.

Past Recalls. Past recalls could be indicative of future recalls. Following the approach taken by Ball et al. (2017), we create a measure of past recalls by counting all recalls experienced by a firm over the past 36 months.[22] Because this variable is positively skewed, we use the natural log of this measure in all analyses.

4.4 Analysis and Results

4.4.1 Empirical strategy

We are interested in identifying the nature of the relationship between environmental controversy and the timing of a product recall announcement. More specifically, we want to understand whether environmental controversy extends or shortens the time to recall, or perhaps, has no impact at all. Given that our dependent variable, the product recall decision, captures time to an event, survival analysis is ideal and has been used extensively in similar settings in the literature (Ball et al. 2017, Harhoff & Wagner 2009, Ramdas & Randall 2008, Bhattacharjee et al. 2007). Two popular categories of methods used to analyze survival data include proportional hazards approaches (PH) and accelerated failure time models (AFT). Proportional hazard models use the hazard function to model the effect of covariates on an event. Exponentiated beta coefficients associated with the covariates yield hazard ratios, which can be interpreted as the instantaneous probabilities at a given time that a failure will occur, as compared to the baseline hazard. The baseline hazard is the probability of a failure at a given time should all covariates equal zero. Hazard ratios greater than 1 are interpreted as an increased probability of an event occurring due to the covariate. Alternately, AFT models capture the relationship between covariates and an event through a survivor function. Exponentiated beta coefficients associated with the covariates yield time ratios, which are interpreted as the expected survival probability at a given time compared to the baseline survivor probability at that same time (when all covariates are set at 0). A time ratio above 1 suggests that the covariate extends the time to the event. In sum, an

[22] We examined our results with 12 and 24 months of past recalls as well and our conclusions remain unchanged.

advantage of AFT models is the ability to directly interpret coefficients as changes in duration, whereas coefficients from PH models relate to changes in risks of exiting the sample at some point in time (Harhoff & Wagner 2009). This feature is especially attractive in our research context, given our desire to predict whether an environmental controversy extends or contracts the time to recall. As such, we analyze our survival data using the AFT model (STREG in Stata).

Accelerated failure time models have been used in similar studies that investigate the future hazard of one event following a different type of event (Harfoff & Wagner 2009, Box-Steffensmeier and Jones 2004). In our setting, we treat each recall as a failure and use the time duration from entry to the date of the recall as our dependent variable, the time to recall. Because there could be multiple recalls for a given firm across the panel, we use a recurrent event, accelerated failure time model, with clustered standard errors at the firm level, and an exponential survival distribution. We chose an exponential survival distribution because this is the most commonly used form of an accelerated failure time model (Box-Steffensmeier and Jones, 2004) and because the instantaneous risk of a recall occurring should be constant over time; however, our results are robust to other distribution choices available in STATA.[23] Note that in an accelerated failure time model, a positive beta coefficient indicates an extended time to recall, while a negative beta coefficient indicates a reduced time to recall.

4.4.2 Results

Descriptive statistics and correlations are provided in Table 4.2. We include time in data (TID) as a proxy for our dependent variable, time to recall (TTR). We first notice that all model variables are correlated with TID. Revenue, return on sales, cumulative past recalls, cumulative controversies (CC), dichotomous controversies, and days since controversy (DSC) are positively correlated, while R&D intensity is negatively correlated with TID. We also notice correlation between variables in our study, which could indicate potential multicollinearity problems. To assess possible multicollinearity concerns, we compute variance inflation factors (VIFs) for control and independent variables in all models. We find that VIFs are less than 2 for variables in each model, indicating a low risk for multicollinearity (Kutner et al. 2005).

[23] Exponential, Lognormal, and Gompertz distributions all produced similar results. Weibull, Loglogistic, and Generalized Gamma distributions did not converge.

Table 4.2 - Descriptive statistics and correlation matrix

		Mean	Min	Max	SD	1	2	3	4	5	6	7	8
1	Time in data	2,093	5	4,375	1,195	1							
2	Revenue	44,282	383	274,102	55,087	0.16*	1						
3	Return on sales	0.10	-1.33	0.85	0.10	0.12*	-0.17*	1					
4	R&D intensity	0.08	0	10.56	0.23	-0.04*	-0.13*	-0.08*	1				
5	Cumulative past recalls	48.59	0	186	39.39	0.38*	0.21*	0.02	0.05*	1			
6	Cumulative controversies	0.52	0	24	1.68	0.14*	0.28*	-0.03	-0.08*	-0.20*	1		
7	Dichotomous Controversies	0.16	0	1	0.37	0.05*	0.41*	-0.07*	-0.07*	-0.20*	0.69*	1	
8	Days since controversy	125.33	0	3332	437.3	0.09*	0.42*	-0.06*	-0.07*	-0.12*	0.61*	0.65*	1

*p<0.05

Note: Variables are non-transformed variables for interpretation purposes

Results from evaluating the direct relationship between environmental controversy and time to recall are presented in Table 4.3. In Hypothesis 1, we propose that managers will delay the product recall to reduce the informativeness of the recall announcement, should it occur, and because it is presents the least risk to their careers. We first include all our control variables (column 1) and observe that each year dummy is positive and significant, indicating a longer time to recall in reference to 2002. We also notice that increased R&D intensity is positively correlated with time to recall, suggesting that firms focused on product development are not only more likely to experience a recall (Thirumalai and Sinha 2011), but also less likely to initiate a recall.

In column 2, we include our binary measure of controversy which captures whether a firm has experienced environmental controversy (1 or more controversies) prior to the recall. Results provide support for Hypothesis 1, as the coefficient for Dichotomous Controversies is positive and statistically significant ($\beta = 0.39$, $p<0.008$). As discussed previously, the exponentiated coefficient represents a time ratio, which is interpreted as a change in the time to recall resulting from a unit change in the independent variable. Thus, a beta of 0.39 corresponds to a time ratio of 1.48, indicating that firms delay a recall by 48% if they had previously experienced environmental controversy.

We subsequently evaluate whether the impact on time to recall is related to the number of environmental controversies a firm has experienced prior to the recall. The results of Cumulative Controversy on time to recall is presented in Column 3. The coefficient ($\beta = 0.09$, $p<0.016$) is positive and statistically significant. The results suggest that each controversy over the measurement window incrementally extends the time to recall by 10%. As a simple robustness check of outliers on this result, we remove firms from the sample which conducted the most recalls. We observe no noticeable changes to our conclusion. As a set, the results suggest that both the presence of environmental controversy and the accumulation of controversies delays the time to recall.[24] Because the Cumulative Controversy measure provides more information than the Dichotomous Controversies measure, we use it in all subsequent models.

[24] Quadratic effects of controversy do not demonstrate any significance

Table 4.3 - Estimation results from AFT models (Time to recall)

	1	2	3
2003	0.98***	0.96***	0.97***
	(0.09)	(0.09)	(0.09)
2004	1.39***	1.35***	1.37***
	(0.11)	(0.11)	(0.11)
2005	1.72***	1.67***	1.70***
	(0.10)	(0.12)	(0.11)
2006	2.02***	1.96***	1.99***
	(0.11)	(0.12)	(0.12)
2007	2.24***	2.15***	2.19***
	(0.14)	(0.14)	(0.14)
2008	2.42***	2.32***	2.35***
	(0.14)	(0.14)	(0.14)
2009	2.57***	2.46***	2.49***
	(0.14)	(0.14)	(0.14)
2010	2.72***	2.61***	2.63***
	(0.14)	(0.14)	(0.14)
2011	2.91***	2.79***	2.82***
	(0.15)	(0.15)	(0.15)
2012	3.07***	2.94***	2.96***
	(0.16)	(0.16)	(0.16)
2013	3.20***	3.07***	3.08***
	(0.18)	(0.17)	(0.17)
ln(Revenue)	-0.09	-0.01	-0.04
	(0.19)	(0.16)	(0.17)
Return on Sales	0.22+	0.21+	0.24+
	(0.13)	(0.13)	(0.13)
ln(R&D intensity)	0.30+	0.31*	0.32*
	(0.15)	(0.16)	(0.16)
ln(Past recalls)	0.05	0.05	0.06+
	(0.04)	(0.04)	(0.04)
Dichotomous Controversy		0.39**	
		(0.15)	
Cumulative Controversy			0.09*
			(0.04)
Constant	23.07***	22.02***	21.86***
	(1.90)	(1.71)	(1.77)
Number of firms	120	120	120
Observations	4509	4509	4509
Wald Chi^2	2139.62	2155.33	2158.47

Standard errors in parentheses, $^{+}$ $p<0.10$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$. Firm fixed effects included, not shown.

We next evaluate Hypothesis 2, in which we postulated that the impact of a controversy on time to recall will diminish as the controversy ages. In Table 4.1 we see that 49 of the total 120 firms experience a controversy during the time-frame of our study and the remaining 71 firms do not. Therefore, these 71 firms do not have values for Days Since Controversy (DSC) and cannot be included in the analysis to evaluate Hypothesis 2. As such, in Table 4.4 we provide the results of the analysis using the 49 firms. For consistency, we first repeat the analysis used to evaluate Hypothesis 1 with our reduced sample (column 1) and find that the results are substantively the same as in Table 4.3, column 3. This lends important support for the recall postponement effect we observed when evaluating Hypothesis 1. We next include DSC (column 2) and then the interaction effect of Cumulative Controversies and DSC (column 3). We observe in column 3 that the interaction term is negative and significant ($\beta = -0.02$, $p<0.01$), providing support for Hypothesis 2. The results indicate that while the effect of Cumulative Controversies remains positive and significant for the set of firms that experience a controversy, this effect is weakened as the time from the most recent controversy increases. However, the small beta also suggests that environmental controversies release their hold on firm behavior very slowly.

Table 4.4 - Estimation results from AFT models (Days since controversy)

	1	2	3
2003	1.22***	1.22***	1.22***
	(0.13)	(0.13)	(0.13)
2004	1.69***	1.72***	1.70***
	(0.15)	(0.15)	(0.15)
2005	1.90***	1.95***	1.92***
	(0.15)	(0.17)	(0.18)
2006	2.29***	2.35***	2.31***
	(0.15)	(0.16)	(0.16)
2007	2.55***	2.65***	2.57***
	(0.19)	(0.20)	(0.19)
2008	2.76***	2.87***	2.78***
	(0.17)	(0.19)	(0.18)
2009	2.77***	2.89***	2.83***
	(0.16)	(0.17)	(0.17)
2010	2.83***	2.97***	2.93***
	(0.25)	(0.21)	(0.22)
2011	3.05***	3.22***	3.20***
	(0.20)	(0.25)	(0.25)
2012	3.23***	3.39***	3.38***
	(0.21)	(0.25)	(0.25)
2013	3.45***	3.58***	3.57***
	(0.21)	(0.25)	(0.26)
ln(Revenue)	-0.15	-0.21	-0.22
	(0.40)	(0.39)	(0.38)
Return on Sales	0.77	0.81	0.79
	(0.55)	(0.53)	(0.51)
ln(R&D intensity)	0.43	0.50	0.64
	(0.79)	(0.81)	(0.76)
ln(Past recalls)	-0.01	0.01	0.01
	(0.08)	(0.08)	(0.08)
Cumulative Controversy	0.10**	0.10**	0.22***
	(0.04)	(0.03)	(0.06)
ln(Days Since Controversy)		-0.03	-0.00
		(0.03)	(0.02)
Cum. Controversy x ln(Days Since Controversy)			-0.02**
			(0.01)
Constant	1.22***	1.22***	1.22***
	(0.13)	(0.13)	(0.13)
Number of firms	49	49	49
Observations	1014	1014	1014
Wald Chi^2	625.42	626.92	629.83

Standard errors in parentheses, $^{+}$ $p<0.10$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$. Firm fixed effects included, not shown.

4.5 Robustness checks

We perform three important robustness checks to rule out the possibility that sample selection bias, reverse causality, and choice of sample are impacting our results. We first address possible sample selection bias resulting from differences in firm characteristics which may predispose a firm to experience a controversy or not. If specific characteristics, such as size or profitability, increase a firm's probability to experience an environmental controversy, these characteristics will be over-represented in the sample of firms experiencing a controversy. Should these same characteristics also impact the timing of a recall, the relationship we observe between an environmental controversy and the timing of a recall may actually be due to these characteristics, rather than the controversy. One way to control for sample selection bias is to perform a nearest neighbor matching analysis (NNMATCH in STATA). In this analysis, firm observations are weighted to ensure both the treated (experienced an environmental controversy) and untreated groups are equally represented with respect to firm characteristics which may impact the timing of a recall. We use recalls over the next 12 months as our dependent variable, our Dichotomous Controversy measure as the treatment variable, and our control and independent variables as matching variables. Results are shown in Table 4.5. The average treatment effect for this matching algorithm is $\beta = -11.5$ ($p<0.0001$), suggesting that experiencing a controversy results in significantly fewer recalls in the subsequent 12 months. Fewer recalls can be interpreted as both recalls that did not happen and recalls which were delayed beyond the evaluation timeframe and thus not counted, providing support for our original conclusion. We conclude that after controlling for aspects of a firm which increase its chances of experiencing a controversy, the occurrence of a controversy seems to delay the recall decision, i.e. sample selection bias is not likely influencing our results.

Table 4.5 - Robustness check – Sample selection bias

Specification	Treatment group[a]	Control group[b]	Average treatment effect on the treated	Standard error	z-statistic	pValue
Nearest neighbor	758	3751	-11.46	2.8	-4.10	0.000

[a]Firms that experienced a controversy
[b]Firms that did not experience a controversy

We next explore how recalls serve to predict, or not predict, environmental controversies. While there is no logical, theoretical reason for a relationship between past recalls and future controversies, we needed to test this relationship to ensure that reverse causality is not present. The presence of reverse causality might suggest that an omitted variable is at least partially responsible for the simultaneous relationship and our conclusions regarding the relationship between controversies and recalls would be suspect. We present the output of our test for reverse causality in Table 4.6. We again evaluate an AFT model in which we changed the failure from a recall to a controversy and the independent variable is now a cumulative count of past recalls.

The control variables remain the same, with the exception that we added a count of prior controversies as an additional control. In this model, reverse causality would be indicated by a significant coefficient connected to Past Recalls. We see no such significance, eliminating concern for reverse causality.

Table 4.6 - Robustness check – Reverse causality (Time to controversy)

	1
2003	0.88*
	(0.40)
2004	1.52*
	(0.60)
2005	2.27**
	(0.77)
2006	2.08**
	(0.70)
2007	2.06***
	(0.44)
2008	2.19***
	(0.56)
2009	2.57***
	(0.59)
2010	2.88***
	(0.61)
2011	3.42***
	(0.72)
2012	3.76***
	(0.78)
2013	3.88***
	(0.67)
ln(Revenue)	-0.41
	(0.80)
Return on Sales	-0.87
	(1.97)
ln(R&D intensity)	2.99
	(2.82)
Cumulative Controversy	-0.08+
	(0.05)
ln(Past recalls)	0.12
	(0.21)
Constant	6.20
	(7.09)
Number of firms	120
Observations	4509
Wald Chi^2	910.12

Standard errors in parentheses, $^{+}$ p<0.10, *p<0.05, **p<0.01, ***p<0.001. Firm fixed effects included, not shown.

As a final robustness check, we restrict our sample to include only firms which experienced both a recall and a controversy. As mentioned previously, our sample includes 3 types of firms; (1) those which experienced a controversy but not a recall, (2) those that experienced a recall but not a controversy, and (3) those which experienced both a recall and a controversy. Each type was included because it provides information important for understanding firm behavior in our research setting. While firms from Group 1 did not recall a product, their competitors did recall products. While the lack of a recall may suggest high product quality, it is also possible that these firms faced quality issues but simply chose not to recall. It was important to capture this unique behavioral profile in our model (Ball et al. 2017). Firms from Group 2 were included because they helped establish a baseline for how firms conduct recalls in the absence of an environmental controversy. However, only Group 3 includes firms which we can be certain experienced both a controversy and a recall, and thus directly provides an opportunity to evaluate the behavioral response of interest, i.e. how firms conduct product recalls following an environmental controversy. We conducted our evaluation exactly as before, but simply limited our sample to firms from Group 3. In total, 26 firms experienced both a controversy and a recall, including 103 controversies and 860 recalls. As observed in Table 4.7, our results did not change. Each controversy extends the time to recall by 10%.

Table 4.7 - Robustness check – Sample selection (Firms with both recalls and controversies)

	1
2003	1.22***
	(0.13)
2004	1.69***
	(0.15)
2005	1.90***
	(0.16)
2006	2.29***
	(0.15)
2007	2.55***
	(0.19)
2008	2.76***
	(0.18)
2009	2.77***
	(0.16)
2010	2.83***
	(0.25)
2011	3.05***
	(0.20)
2012	3.23***
	(0.21)
2013	3.45***
	(0.21)
ln(Revenue)	-0.15
	(0.41)
Return on Sales	0.77
	(0.56)
ln(R&D intensity)	0.43
	(0.80)
ln(Past recalls)	-0.01
	(0.08)
Cumulative Controversy	0.10**
	(0.04)
Constant	6.35
	(4.33)
Number of firms	26
Observations	963

Standard errors in parentheses, $^{+}$ p<0.10, *p<0.05, **p<0.01, ***p<0.001. Firm fixed effects included, not shown.

4.6 Post hoc

In this analysis, we address the disparate recall industries in our study. Note that while we could not include industry fixed-effects in the primary analysis of Table 4.3, because those measures would be perfectly collinear with our firm fixed-effects, the current analysis effectively accomplishes that objective by testing how our relationships hold, or do not hold, across the different recalling industries. A priori, we would expect that firms in industries which may be more sensitized to environmental issues may respond differently to an environmental controversy than firms from other industries. For example, firms in the automotive industry may be more sensitive to environmental issues because while all industries in which a product is manufactured must adhere to environmental rules, regulations and expectations related to the manufacturing process, the automotive industry is the only one in our sample that also creates a product which negatively impacts the natural environment. We observe in Table 4.8 that our results are quite consistent across industries, with each recall industry demonstrating a significant or moderately significant relationship between Cumulative Controversies and the time to recall. Interestingly, the automotive industry and the consumer products industry demonstrate the largest effect sizes, with firms in these industries delaying recalls following an environmental controversy by 82% and 93% respectively.[25]

[25] We are not able to test Hypothesis 2 at an industry specific level because of the low sample size of controversies and recalls within each unique industry.

Table 4.8 – Post hoc - AFT model - Hazard of a recall (by industry)

	All	Auto	Pharma	Med Device	Food	Consumer
Model	1	2	3	4	5	6
2003	0.97***	1.25***	0.58***	0.60***	0.81	1.41***
	(0.09)	(0.05)	(0.11)	(0.17)	(0.63)	(0.15)
2004	1.37***	1.81***	0.90***	0.86***	1.38*	1.93***
	(0.11)	(0.07)	(0.16)	(0.19)	(0.54)	(0.25)
2005	1.70***	1.96***	1.18***	1.36***	1.58**	2.05***
	(0.11)	(0.11)	(0.18)	(0.29)	(0.58)	(0.20)
2006	1.99***	2.41***	1.46***	1.63***	1.99**	2.42***
	(0.12)	(0.10)	(0.20)	(0.32)	(0.65)	(0.31)
2007	2.19***	2.72***	1.64***	1.81***	2.03**	2.47***
	(0.14)	(0.16)	(0.18)	(0.37)	(0.76)	(0.24)
2008	2.35***	2.84***	1.84***	1.96***	2.42**	2.51***
	(0.14)	(0.15)	(0.17)	(0.38)	(0.86)	(0.31)
2009	2.49***	2.83***	1.98***	2.11***	2.41**	2.94***
	(0.14)	(0.08)	(0.17)	(0.39)	(0.86)	(0.23)
2010	2.63***	2.82***	2.09***	2.28***	2.89**	3.24***
	(0.14)	(0.18)	(0.18)	(0.40)	(1.07)	(0.33)
2011	2.82***	3.12***	2.16***	2.50***	2.94*	3.54***
	(0.15)	(0.13)	(0.19)	(0.42)	(1.20)	(0.43)
2012	2.96***	3.33***	2.25***	2.65***	2.92*	3.70***
	(0.16)	(0.14)	(0.20)	(0.44)	(1.26)	(0.42)
2013	3.08***	3.55***	2.33***	2.77***	2.39*	3.53***
	(0.17)	(0.19)	(0.22)	(0.44)	(1.02)	(0.44)
ln(Revenue)	-0.04	-0.43+	0.10	-0.07	-0.85	0.42
	(0.17)	(0.25)	(0.12)	(0.31)	(1.36)	(0.61)
Return on Sales	0.24+	1.53*	-0.28	0.21	-0.70	1.03
	(0.13)	(0.72)	(0.23)	(0.17)	(2.89)	(0.92)
ln(R&D intensity)	0.32*	5.65	-0.23	0.11	2.26***	1.03***
	(0.16)	(4.35)	(0.76)	(0.11)	(0.36)	(0.21)
ln(Past recalls)	0.06+	-0.16	0.11*	0.12+	0.57***	-0.00
	(0.04)	(0.16)	(0.05)	(0.06)	(0.14)	(0.08)
Cumulative Controversy	0.09*	0.15*	0.03+	0.06*	0.11***	0.16***
	(0.04)	(0.06)	(0.02)	(0.02)	(0.02)	(0.03)
Constant	21.86***	10.22***	2.18*	23.11***	11.32	-0.16
	(1.77)	(2.93)	(0.95)	(2.81)	(12.23)	(6.10)
Number of firms	120	9	15	39	23	35
Observations	4509	1069	1243	1787	166	244
Wald Chi^2	2139.62	2158.47	594.41	474.76	743.28	134.57

Standard errors in parentheses, $^{+}$ p<0.10, *p<0.05, **p<0.01, ***p<0.001. Firm fixed effects included, not shown.

4.7 Discussion

Our study makes three important contributions. First, it bridges an important gap between environmental and operations management research. While prior researchers have demonstrated that environmental failures which become public controversies result in market share and reputational losses, we demonstrate that they also impact important operational decisions, such as the timing of a product recall. We find that after controversies occur, or accumulate over time, firm managers seem to be inclined to postpone announcing product quality problems, possibly due to career concerns. While each additional controversy incrementally adds to the postponement, an average firm experiencing negative environmental pressure extends the time to recall by almost 50%. Given the significant consequences of a recall, such delays have important implications to both firms and consumers.

Further, while we observe in Hypothesis 2 that the impact of a controversy on firm behavior diminishes over time, the pace of this decay is very slow. Interpreting the interaction term associated with Hypothesis 2 shows that avoiding a controversy for three years only reduces the impact of prior controversies on time to recall by about 20%. Thus, not only do environmental controversies significantly impact time to recall, but this influence lasts for many years. Our results are robust to sample selection bias, reverse causality, and choice of firms we include in the sample.

One implication of our findings is that regulators should be aware of this postponement tendency and be on the lookout for firms experiencing both environmental and product challenges. Regulators might need to consider working across traditional boundaries to identify and track such companies, such as the EPA working with the FDA, NHTSA or CPSC. These findings contribute to the environmental literature by identifying a consequence of poor environmental performance not previously studied. They also contribute to the literature on product recalls. While many studies have treated recalls as an objective measure of product quality, we find evidence for the fact that the timing of when a recall is initiated has some discretion, as it appears that managers are likely to postpone recalling products when they are experiencing negative environmental pressure.

Second, our study is the first to find a common leading indicator of recall timing across all major recalling industries in the United Sates (auto, pharma, medical device, food, and consumer products), making it the broadest recall study to-date. In our post hoc analysis, we observe that the desire to postpone recalls after experiencing environmental controversy is prevalent for firms in all recalling industries. We also observe that firms who make products which negatively impact the environment, such as automobiles, are especially sensitive to this postponement effect. As shown in Table 8, the effect size for the auto recall industry is more than 35% larger than that for any other recalling industry, with the exception of the consumer products industry which has a similar effect size. The results provide additional support for our earlier recommendation that cross-governmental agency collaboration may be required to effectively monitor offending companies, as the recall postponement effect is not limited to the jurisdiction of one agency.

Finally, our study contributes to the body of literature that explores how firms manage multiple instances of bad news within the same firm. The limited research in the area examines only instances of bad news which are related, such as financial performance, and evaluates them in a limited number of industries. In contrast, we evaluate seemingly-unrelated bad news events across a broad variety of industries. Our results may also be generalizable to a broader set of issues and decisions. While we evaluate one specific issue that sensitizes a firm to additional bad news, an environmental controversy, firms experience a broad variety of negative publicity which may similarly sensitive them and impact subsequent discretionary decisions. Examples include negatively publicity related to corporate misdeeds, such as theft, bribery or accounting scandals, or concerns about social policies/performance, such as layoffs, overseas outsourcing, strikes or unfavorable labor practices. Further, beyond recalls, firms make a myriad of important decisions which face public scrutiny and thus may be biased due to a firm's existing sensitivity to public scrutiny. If biased, the decisions could be flawed, to the detriment of the firm or others. Examples include mergers and acquisitions, outsourcing, and labor decisions. While it is difficult to predict firm behavior in these myriad of scenarios, an overarching conclusion from our research is that when firm managers make decisions which will be scrutinized by the public, and are already sensitive to negative publicity, they pursue paths which present the least risk to their careers and their firms.

4.8 Limitations and Venues for Future Research

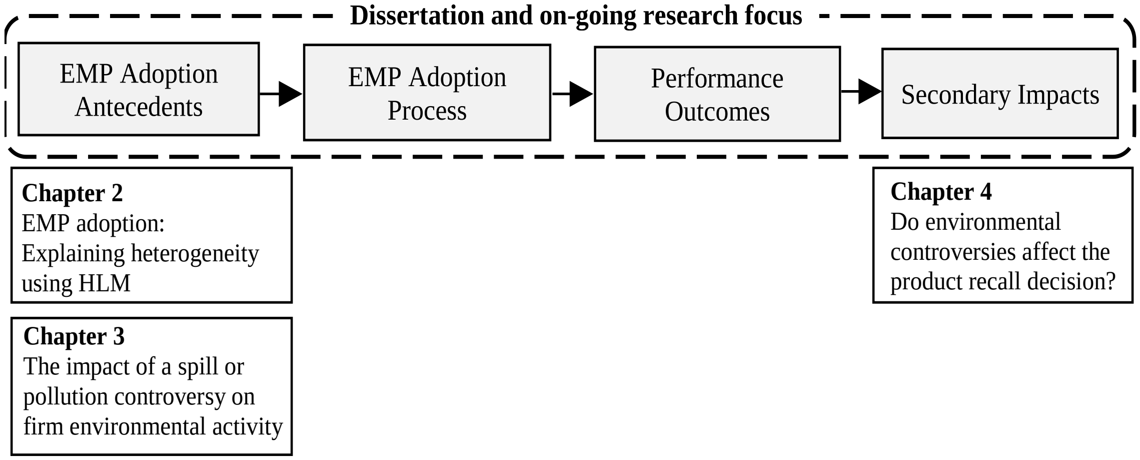
While we feel that the results provide convincing evidence of a product recall postponement effect for firms experiencing public environmental pressure, our study is not without limitations. One limitation is our inability to know when firms first consider a recall so we can more accurately capture the time to recall. Lacking this information, we use time in data since the initiation of data gathering as a proxy. While our study includes a large volume of recalls, allowing pooling of recall start times across large samples, it is less precise than using actual start times when firms first consider a recall. A second limitation is the rather small sample size of firms within each recalling industry. While we evaluate 154 controversies, 4355 recalls, and 120 firms in our study, our sample is spread across five different recalling industries. While we evaluate the majority of firms in the auto industry, the same is not true for the remaining recalling industries. While the selection of firms for our analysis was random, it is possible that the firms we evaluate behave differently than their peers. As a future research opportunity, it would be interesting to use case study methods to better understand the mechanism by which firms process negative publicity and how this negative publicity translates into decision making. Finally, it would have been nice to capture a broader picture of a firm's positive and negative experiences during the study period. While adding such a control would add robustness to our results, it is not a serious concern given the large number of firms in our sample and the extensive length of our panel.

Research evaluating how firms respond to multiple incidents of bad news within the same firm is sparse. As such, our research setting lends itself to a variety of interesting future research opportunities. One opportunity would be to better understand how firms process negative publicity. Such an understanding would enable firm managers to understand their own behavioral biases and assess their detrimental impact on decision making and firm performance. A related line of inquiry could focus on analytical modeling to develop decision models for optimal decision making when the same firm experiences multiple incidents of negative publicity. A third opportunity for future research would be to empirically understand which other forms of negative publicity sensitize firms to additional negative publicity, like environmental controversies. As mentioned previously, events which draw negative publicity towards a firm, such as scandals or unpopular social practices, seem to be increasingly common. It would also be interesting to study if certain forms of good publicity could mitigate or even reverse the behavioral effect we observe following an environmental controversy. A final idea for future research is to understand whether other important firm decisions may be impacted by events which bring negative publicity to a firm, such as mergers and acquisitions, outsourcing, or layoffs. These weaknesses notwithstanding, we believe that our research makes an important first step by linking two seemingly-unrelated instances of bad news.

Chapter 5 - Conclusion

Through their operations, firms of all types negatively impact the natural environment. This happens through some combination of resource consumption (energy, natural resources, and water) and operational waste emission (hazardous and non-hazardous) into the air, land, and water. The magnitude of the impact is significant. For example, the consumption of energy produced in fossil-fuel powered plants produces enormous quantities of greenhouse gases, which in turn contribute to global warming and climate change. Experts estimate that by 2030, global warming will result in 250,000 additional deaths annually around the globe and $2 billion - $4 billion in additional healthcare spending in the United States alone. Further, harmful emissions result in 100 million deaths annually around the globe, 3 million of which are children under the age of five. Firms reduce the impact of their operations, or their supply chain, on the natural environment by adopting operational changes called environmental management practices (EMPs). However, while firms "on average" steadily adopt more EMPs each year, across all sectors, there is tremendous variation in adoption across firms, even for firms in a common sector or industry. My dissertation investigates this variation in adoption from two perspectives; what contributes to the variation and how does poor environmental performance resultant from that variation impact firm operational decision-making. The answers to these broad questions have the potential to substantially inform the development of new or revised approaches to encourage firms to be more environmentally responsible and reduce the impact of their operations on the natural environment. I conduct the investigations through three (3) essays, each of which individually contributes to the broader investigation (see Figure 5.1). Each chapter's individual contribution is summarized below, including areas for future research. I conclude with two important themes that can be derived from a holistic examination of the results of this dissertation.

Figure 5.1 – Dissertation structure



In Chapter 2, I investigate how stakeholders, firm characteristics, and industry attributes contribute to variation in EMP adoption. More specifically, I address two questions: (1) which stakeholders seem to have greater (or lesser) influence on firm-level decisions regarding the adoption of EMPs and (2) which specific firm characteristics and industry attributes support or hinder EMP adoption. Using panel data from 2002 to 2013 and Hierarchical Linear Modeling (HLM; Bryk & Raudenbush 1992), I show that the passage of time, firm-unique choices and characteristics, and industry membership account for 40.0%, 25.7%, and 34.3% respectively of the aggregate variance in EMP adoption. This suggests that stakeholders that influence firms directly (firm explanation - 25.7%) are almost as important to adoption choices as regulators, who influence firms through the industry in which the firm competes (34.3%). Such knowledge could be valuable in the development of new or revised approaches to incent firms to be more environmentally responsible. Results from analyzing firm characteristics show that firm leaders beginning the journey toward environmental excellence should be aware of the importance of available labor, of the complementary benefit of having already adopted a quality management system (such as lean, TQM or Six Sigma), and that much can be done without excess capital. Results from analyzing industry attributes show that as environmental uncertainty increases, firms adopt fewer EMPs, i.e. firms do not see the adoption of EMPs as necessary to grow the firm, address industry instability or handle industry complexity. Avenues for future research include examining a more expansive set of firm characteristics and industry attributes, and investigating possible interactions between sectors and industry strategic factors.

In Chapter 3, I investigate the impact of a spill or pollution controversy on variation in firm environmental activity, as measured by the adoption of EMPs. Such controversies are increasingly common. Also, given the direct connection between EMP adoption and improved firm environmental performance, understanding how firms respond to such controversies (escalate or de-escalate adoption) is of importance to both society and regulators. Using a panel dataset focused on U.S. manufacturers and spanning from 2002 to 2013, I find that in the absence of a spill or pollution controversy firms in all sectors steadily adopt more EMPs each year. However, in the year following a spill or pollution controversy they de-escalate annual increases in adoption and this effect seems to persist for up to 3 years. I also observe that high sustainability firms do not de-escalate adoption following an environmental controversy, suggesting that such firms respond differently to spill or pollution controversies than other firms. These results have significant negative implications for short- and long-term environmental performance, especially since firms do not seem to recover from the slowdown in future years. The results also shed light on a commonly held belief that firms increase EMP adoption in response to an environmental controversy, perhaps to strengthen their environmental management system or achieve legitimacy in their stakeholders' eyes. Instead, firms (in aggregate) de-escalate annual increases in adoption following a controversy and this behavior persists over time, potentially resulting in a complete pause in adoption. The results also indicate that factors other than stakeholder or institutional pressure, the primary theoretical lenses from which EMP adoption has been studied previously, influence firm decisions regarding EMP adoption (Delmas 2001, Delmas & Toffel 2008, Reuter et al. 2010, Sarkis et al. 2010, Foster et al. 2000, Hofer et al. 2012). Avenues for future research include evaluating whether the de-escalation in adoption results in a slowdown of environmental performance improvements as well, evaluating whether firms from other countries behave similarly following a spill or pollution controversy, assessing whether other types of negative firm events (such as product recalls) impact on-going EMP adoption, and finally, evaluating whether adopting more EMPs reduces the frequency of future spill or pollution controversies.

Finally, in Chapter 4, I investigate how EMP adoption choices, and associated environmental performance, impact seemingly-unrelated operational decisions. I specifically investigate whether firms who have experienced prior environmental controversies, and the associated fallout from such socially toxic events, choose to accelerate or decelerate subsequent voluntary product recalls, which are also socially toxic events. Using a proprietary dataset which includes 120 publicly traded firms from 59 4-digit SIC code industries, 154 environmental controversies, 4355 product recalls representing all major recall industries, and survivor modeling, I find that a spill or pollution controversy causes firms to delay the product recall decision and that the affect occurs across all recalling industries. I also find that the impact of the controversy on the recall decision diminishes as the time between the controversy and recall increases, although the rate of decay is extremely slow. This last result demonstrates that spill and pollution controversies impact firm behavior for many years. An implication of the findings is that regulators should be aware of this postponement tendency and be on the lookout for firms experiencing both environmental and product challenges. Regulators might even consider working across traditional boundaries to identify and track such companies, such as the EPA working with the FDA, NHTSA or CPSC. Avenues for future research include case studies to understand the mechanism by which firm leaders process negative publicity, analytical modeling to develop decision models for optimal decision making, and empirical studies to determine which other forms of negative publicity sensitize decision-makers like an environmental controversy, and which other firm decisions may be influenced by existing negative publicity like a product recall.

To highlight the similarities and differences across each chapter, I provide an overview of the dissertation in Table 5.1. It is worth noting that the dataset used in each essay is unique to that essay with the ASSET4 database from Thomson Reuters providing the common platform. The ASSET4 database is extremely large (almost 60k rows) and was initially developed for Wall Street analysts. Because it is not configured for academic research, downloading, cleaning, and combining it with other economic databases (e.g. COMPUSTAT) required extensive effort. I also use a broad variety of theories and econometric techniques in my three essays. As to the content of the essays, Chapters 2 and 3 focus on identifying the sources of variation in EMP adoption, while Chapter 4 investigates the impact of that variation on operational decision-making.

Table 5.1 - Dissertation summary

	Chapter 2	Chapter 3	Chapter 4
Title	EMP Adoption: Explaining heterogeneity among firms	The impact of a spill or pollution controversy on firm environmental activity	Do environmental controversies affect the product recall decision?
Industry	Broad (6 sectors, 103 unique industries)	Manufacturing industries	Pharma, auto, medical device, consumer products
Unit of Analysis	Firm-year	Firm-year	Firm-year
Data (Years)	Secondary (2002 – 2013)	Secondary (2002 – 2013)	Secondary (2002 – 2013)
Research Question(s)	* Which stakeholders seem to have greater (or lesser) influence on firm-level EMP adoption decisions? * Which firm & industry attributes support or hinder EMP adoption?	What impact does a spill or pollution controversy have on firm decision making regarding the adoption of EMPs?	Does an environmental controversy affect the timing of a product recall?
Research method	Hierarchical (Nested) Linear model	Fixed- and random-effect negative binomial, OLS, Zero-inflated negative binomial, Poisson, Generalized estimating equation, and Propensity score matching	Accelerated Failure Time model
Theoretical Lens	Stakeholder theory, institutional theory, resource-based view of the firm, natural-resource based view of the firm	Self-justification theory, belief persistence & escalation of commitment theory, status quo bias, organizational learning and change, attention-based view of the firm	Threat-rigidity hypothesis, attention-based view of the firm, prospect theory
Implications	* Stakeholders that influence firms directly are as important to EMP adoption as regulation * Critical antecedents to EMP adoption include available labor and prior adoption of a quality management system. Available capital is NOT a requirement.	* Firms, on-average, adopt more EMPs every year * Following a spill or pollution event, firms decelerate annual increases and this impact lasts for up to 3 years * Firms committed to sustainability do NOT decelerate adoption following a spill or pollution event	* A spill or pollution controversy causes firms to delay a voluntary product recall decision, i.e. they prefer to separate instances of bad news * The impact of a controversy on the recall decision diminishes as the time between the controversy and the recall increases

It is important to underscore that ASSET4 is relatively unused in academic research and could constitute a critical resource for future researchers focused on EMP adoption, as well as projects focused on other environmental topics or the broader topic of sustainability. The vast majority of existing EMP adoption studies use primary data, including surveys and case studies.

Only recently have researchers begun to collect data from various secondary sources such as annual reports, 10k filings, corporate sustainability reports, and websites (Hofer et al. 2012, Tate 2010, Montabon et al. 2007, Sroufe et al. 2003). Conducting environment research using secondary data could be a valuable compliment to survey research.

Given the behavioral complexities underpinning the decisions firm leaders make to adopt EMPs (or not), investigating variation in firm environmental activity is a challenging, complex, and significant task. This dissertation adds to an already robust, but growing literature in this area. Two significant themes emerge from the dissertation. First, factors other than stakeholder and institutional pressure impact firm decisions regarding environmental activity. In Essay 2, I find that various firm and industry attributes impact such decisions. In Essay 3, I find that environmental controversies cause many firms to de-escalate annual increases in adoption observed in the absence of a controversy. While the results add to our understanding of antecedents to the adoption of EMPs, I believe they also reinforce the conclusion that a full understanding of the process by which firm leaders make such decisions is far from complete. A second key theme to emerge from this dissertation is that firm decisions regarding EMP adoption impact firms in surprising and unexpected ways. In Essay 4, I show that poor environmental performance (as measured by an environmental controversy) results in delayed product recalls. However, if firm environmental performance is a direct consequence of EMP adoption decisions, as many researchers have demonstrated, our results show a surprising and previously unstudied link between firm environmental activity and product quality decision making. Given the significant ramifications of product recalls for consumers, firms, and regulators, this link is critically important for researchers and regulators alike.

In summary, through this dissertation I provide input to two broad questions regarding variation in EMP adoption across firms, i.e. what drives that variation and how that variation impacts operational decision-making. Numerous additional questions remain unanswered. Beyond examining other antecedents to variation in adoption and the impact of that variation on other important firm decisions, Figure 5.1 shows that much needs to be done in understanding the process of adoption, as well as the relationship between adoption variation and environmental performance. My hope is that this dissertation will spur other researchers to continue the journey toward understanding firm behavior regarding their willingness to make the operational changes required to reduce the impact of their operations on the natural environment. Such a journey is of the highest priority should we desire to preserve the planet for future generations.

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Appendix A - Environmental Management Practices (EMPs) used in research

Asset4 Code	Title/Description	Assessment	Freq.
enerdp0011	Emission Reduction Policy Elements/Emissions	Does the company have a policy to reduce emissions?	1910
enerdp0012	Emission Reduction Policy Elements/Biodiversity	Does the company have a policy to reduce its impact on biodiversity?	599
enerdp0013	Emission Reduction Policy Elements/ Environmental Management Systems	Does the company have a policy to maintain an environmental management system?	1447
enerdp0051	Emission Reduction Processes/Emissions	Does the company describe, claim to have or mention processes in place to improve emission reduction?	1464
enerdp0052	Emission Reduction Processes/Biodiversity	Does the company describe, claim to have or mention processes in place to reduce its impact on biodiversity?	611
enerdp0053	Emission Reduction Processes/ Environmental Management Systems	Does the company describe, claim to have or mention processes in place to maintain an environmental management system?	1040
enerdp006	CERES Valdez Principles	Is the company endorsing the CERES principles (or Valdez principles)?	74
enerdp0101	Emission Reduction KPI Monitoring/Emissions	Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor emission reduction?	683
enerdp0102	Emission Reduction KPI Monitoring/Biodiversity	Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor its impact on biodiversity?	21
enerdp0103	Emission Reduction KPI Monitoring/ Environmental Management Systems	Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor its use of an environmental management system?	46
enerdp020	Biodiversity Restoration Protection	Does the company report on initiatives to restore or protect native ecosystems or the biodiversity of protected and sensitive areas?	690
enerdp028	CO2 Equivalents Emission Reduction Production	Does the company show an initiative to reduce, reuse, recycle, substitute, phased out or compensate CO2 equivalents in the production process?	777
enerdp029	CO2 Equivalents Emission Reduction Transportation	Does the company show an initiative to reduce, reuse, recycle, substitute or phase out CO2 equivalents in the product transportation process?	487
enerdp062	Waste Reduction Total	Does the company report on initiatives to recycle, reduce, reuse, substitute, treat or phase out total waste?	1532
enerdp063	e-Waste Reduction	Does the company report on initiatives to recycle, reduce, reuse, substitute, treat or phase out e-waste?	449

enerdp067	Production Concentration	Does the company report on the concentration of production locations in order to limit the environmental impact during the production process?	70
enerdp068	Emissions Trading	Does the company report on its participation in any emissions trading initiative?	369
enerdp069	New Production Techniques	Does the company report on new production techniques to improve the global environmental impact (all emissions) during the production process?	471
enerdp070	Environmental Partnerships	Does the company report on partnerships or initiatives with specialized NGOs, industry organizations, governmental or supra-governmental organizations, which are focused on improving environmental issues?	1415
enerdp076	Environmental Restoration Initiatives	Does the company report or provide information on company-generated initiatives to restore the environment?	721
enerdp081	Staff Transportation Impact Reduction	Does the company report on initiatives to reduce the environmental impact of transportation used for its staff?	536
enerdp082	Logistics and Product Transportation Impact Reduction	Does the company report on initiatives to reduce the environmental impact of the transportation of its products?	728
enerdp095	Environmental Investments Initiatives	Does the company report on making proactive environmental investments or expenditures to reduce future risks or increase future opportunities?	400
enpidp0011	Product Innovation Policy Elements/Life Cycle Assessments	Does the company have a product life-cycle assessment policy?	1007
enpidp0012	Product Innovation Policy Elements/Eco Design	Does the company have an eco-design policy?	953
enpidp0013	Product Innovation Policy Elements/De-materialization	Does the company have a de-materialization policy?	299
enpidp0014	Product Innovation Policy Elements/Product Innovation	Does the company have a general, all-purpose policy regarding environmental product innovation?	1233
enpidp022	Energy Footprint Reduction	Does the company describe initiatives in place to reduce the energy footprint of its products during their use?	848
enrrdp0011	Resource Efficiency Policy Elements/Water Efficiency	Does the company have a policy to improve its water efficiency?	1386
enrrdp0012	Resource Efficiency Policy Elements/Energy Efficiency	Does the company have a policy to improve its energy efficiency?	1907
enrrdp0013	Resource Efficiency Policy Elements/Resource Efficiency	Does the company have a general, all-purpose policy regarding resource efficiency?	2096
enrrdp0015	Resource Efficiency Policy Elements/ Environmental Supply Chain	Does the company have a policy to lessen the environmental impact of its supply chain?	1508

enrrdp004	Environment Management Team	Does the company have an environmental management team?	1365
enrrdp008	Environment Management Training	Does the company train its employees on environmental issues?	1414
enrrdp011	Environment Management Improvement Tools	Does the company have the appropriate internal communication tools (whistle blower, ombudsman, suggestion box, hotline, newsletter, intranet, etc.) to ensure better environmental management?	1446
enrrdp0121	Resource Efficiency Processes/ Water Efficiency	Does the company describe, claim to have or mention processes in place to improve its water efficiency?	1192
enrrdp0122	Resource Efficiency Processes/ Energy Efficiency	Does the company describe, claim to have or mention processes in place to improve its energy efficiency?	1593
enrrdp0123	Resource Efficiency Processes/Resource Efficiency	Does the company describe, claim to have or mention processes in place to improve its resource efficiency in general?	1287
enrrdp0125	Resource Efficiency Processes/Environmental Supply Chain	Does the company describe, claim to have or mention processes in place to include its supply chain in the company's efforts to lessen its overall environmental impact?	3573
enrrdp0131	Resource Efficiency KPI Monitoring/Water Efficiency	Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor water efficiency?	564
enrrdp0132	Resource Efficiency KPI Monitoring/Energy Efficiency	Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor energy efficiency?	634
enrrdp0133	Resource Efficiency KPI Monitoring/Resource Efficiency	Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor resource efficiency in general?	274
enrrdp0135	Resource Efficiency KPI Monitoring/Environmental Supply Chain	Does the company claim to use key performance indicators (KPI) or balanced scorecard to monitor the environmental impact of its supply chain?	59
enrrdp029	Materials Sourcing Environmental Criteria	Does the company claim to use environmental criteria (e.g., life cycle assessment) to source or eliminate materials?	902
enrrdp046	Renewable Energy Use	Does the company make use of renewable energy?	982
enrrdp052	Green Buildings	Does the company report about environmentally friendly or green sites or offices?	741
enrrdp053	Energy Efficiency Initiatives	Does the company report on specific initiatives to improve its energy efficiency?	1394
enrrdp057	Water Efficiency Initiatives	Does the company report on initiatives to reuse or recycle water?	1024
enrrdp058	Environmental Supply Chain Management	Does the company use environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners?	1193

enrrdp059	Environmental Supply Chain Partnership Termination	Does the company report or show to be ready to end a partnership with a sourcing partner, if environmental criteria are not met?	427